SEA TURTLE MANUAL OF RESEARCH AND CONSERVATION TECHNIQUES

Prepared for the

WESTERN ATLANTIC TURTLE SYMPOSIUM

— W A T S —

A SYMPOSIUM ON
SEA TURTLE RESEARCH
OF THE WESTERN CENTRAL ATLANTIC
(POPULATIONS AND SOCIO-ECONOMICS)

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SEA TURTLE MANUAL OF RESEARCH AND CONSERVATION TECHNIQUES

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SEA TURTLE MANUAL OF RESEARCH AND CONSERVATION TECHNIQUES

A. Purpose of this Manual

This Manual was prepared primarily to assist in planning and research for the 1982 and 1983 field research programme of the *Western Atlantic Turtle Symposium (WATS).* This *Symposium on Sea Turtle Research in the Western Central Atlantic (Populations and Socio-economics)* is being planned and sponsored by the Intergovernmental Oceanographic Commission Association for the Caribbean and Adjacent Regions (IOCARIBE) with the cooperation of the UNDP/FAO Inter-regional Fisheries Development and Management Programme (WECAF).

A *National Report Form* is being distributed to all Western Central Atlantic nations participating in the Symposium and its research. The form outlines the data to be collected and documented (where and as available) for use by the National Representatives to the Symposium. This Manual is intended to assist in the preparation of that *National Report Form.*

Twelve authors have contributed to this First Edition, with Peter C. H. Pritchard as senior author. The authors recognize that unanimity in all aspects of sea turtle research and conservation has not been reached; a variety of methodologies appear in the published literature. Moreover, research techniques often depend upon local customs and circumstances. Rather than include every known technique or involve the readers in extensive debates, we give the techniques we jointly consider "recommended" or "preferred", followed where appropriate by "alternatives". In similar fashion, we offer draft outlines of the types of data recording forms that have proved successful in sea turtle surveys.

This effort, planned as an initial working document for the Western Atlantic area and its six sea turtle species, has been broadened slightly to include the other species, the flatback sea turtle of Australia and New Zealand, and the black turtle of the eastern Pacific.

A.1 Acknowledgements

This Manual was prepared under the sponsorship of the Intergovernmental Oceanographic Commission Association for the Caribbean and Adjacent Regions (IOCARIBE).

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Later editing of the Manual and preparation of some illustrations were supported by the grant from the Sea Turtle Rescue Fund, a project of the Center for Environmental Education, Washington, D.C.

The drawings were prepared by Marvin Bennet of Orlando, Florida, and John Datillo, Applied Biology, Inc., Atlanta, Georgia.

Publication of such a Manual was recommended by Peter Bacon, in 1975 (F.A.O. Fisheries Bulletin, No. 334, p. 15).

The authors are grateful to the following for editorial comments on the penultimate manuscript draft: George H. Belazs, Thomas H. Fritts, David J. Herrema, Sally Hopkins, Albert Jones, Charles Karnella, Anne Meylan, Nicholas Mrosovsky, Charles A. Oravetz, Robert Shoop, Nancy Thompson and Michael Weber.

The Spanish version of the Manual was translated by Pedro E. León, and was edited by Douglas Robinson, both of the University of Costa Rica, San José.

The final manuscripts were typed and compiled by María Teresa Koberg, San José, Costa Rica.

B. Requirements for a Programme of Sea Turtle Research and Conservation

The nature of local turtle populations and constraints on time, resources and manpower determine the requirements and components of turtle programmes. From a global standpoint, the main need is for valid scientific data: which species occur where; local and regional population sizes; and historical population sizes. Knowing the nature and extent of human exploitation and any other features that may affect the sea turtle populations is also important. Usually, the research programme will stress the terrestrial phase of the life cycle-nesting females, eggs, and hatchlings. Consequently, most research will take place during the few months of the nesting season.

B.1 Species Identification

Species identification, which may be made at any developmental stage, from embryo to adult, is essential. Tracks and nests also may be related to individual species. The distinct ecology and migratory habits of different species must be understood for scientific conservation.

B.2 Habitat Description and Inventory

The first stage of any survey should consist of recording and classifying the types and distribution of existing coastal habitats which are, or may be, used by sea turtles. This inventory may be done at any time of year, but must be updated as data accumulate from other aspects of the programme. A survey of beach types is essential for detailed planning of aerial and ground surveys. Pelagic surveys can provide valuable information on foraging areas and migratory habits.

B.3 Survey Techniques

For ground surveys, sampling unit areas must be established to facilitate later statistical analysis of data. The Manual explains what to look for, how to measure and tag turtles, and how to estimate hatching success. These factors form the basis of accurate population estimates.

The best way to ensure that survey data are accurately recorded is to use standardized data record sheets prepared in advance and available to all survey team members. The *National Report Form* contains these record sheets.

B.4 Sea Turtle Exploitation Surveys

Biological data must be supplemented by assessments of human impact. What vessels are operating in the area? What is the fishery and incidental catch rate? How are products marketed, both locally and internationally? A number of sources, including official statistics and interviews with fishermen and local residents, can yield such data.

B.5 Sea Turtle Conservation Techniques

The key to management and conservation is protecting the remaining sea turtle stocks under conditions which are as natural as possible. A sea turtle programme should consider the control of all predators, the control or prevention of other causes of mortality, the protection of eggs and nests, and the need for incubation or artificial hatchery operations.

B.6 Sociological Factors

Turtle populations cannot be conserved and restored unless fishermen, vendors and the public co-operate. A complete sea turtle programme must consider legislation and its enforcement, the establishment and the protection of sanctuaries, continuous population monitoring and public education.

B.7 Captive Maintenance of Sea Turtles

Although this Manual is not concerned with commercial turtle farming, it outlines optimal conditions for maintaining juvenile and adult turtles in captivity where such cultures are practical and beneficial.

B.8 Summary

An effective sea turtle research and conservation programme is complex and could become expensive. We have attempted to provide sufficient information for anyone wishing to embark on some or all of the aspects involved. We emphasize that the status of many of the world's turtle populations is changing rapidly and critically. All sea turtle observations, whether a single sighting or the records of an entire season's nesting, are potentially of great value. Only if they are recorded and reported will we be able to minimize the lack of information that now hampers many conservation programmes.

C. Survey Techniques

C.1 Identification of Species

C.1.1 Scientific and Vernacular Names

Hundreds of different vernacular of common names are used throughout the world. In some areas, local fishermen have several names for slightly different color phases or age cohorts of the same species. Except for *Chelonia depressa* of the Indo Pacific region, the names that appear most regularly in popular and scientific literature and that fishermen of the Caribbean and Western Atlantic use commonly are:

a) *Lepidochelys kempi:*
Kemp's ridley (Preferred English)
Tortuga lora del Atlántico (Preferred Spanish)
Atlantic ridley
Mexico ridley
Grey loggerhead
Tortuga boba (Latin America)
Bastard turtle (old literature)

b) *Lepidochelys olivacea:*
Olive ridley (Preferred English)
Tortuga golfina (Preferred Spanish)
Pacific ridley
Warana (Suriname)
Tortue olivátre (French Guiana)
Xibirro (Brazil)

c) *Eretmochelys imbricata:*
Hawksbill (Preferred English)
Carey (Preferred Spanish)
Oxbull (Caribbean English)
Tortue des bonnes ecilles (French)
Tortue imbriquée (French Guiana)
Karet (Suriname)
Tartaruga de pente (Brazil)

d) *Caretta caretta:*
Loggerhead (Preferred English)
Caguama (Preferred Spanish)
Cabezona
Logrit (Caribbean English)
Onechte karet (Suriname)
Caguanne (French Guiana)
Avo de tartaruga (Brazil)

e) *Chelonia mydas:*
Green turtle (Preferred English)
Tortuga verde (Preferred Spanish)
Greenback turtle (Caribbean English)
Edible turtle
Soup turtle

Tortue verte (French Guiana)
Tortuga blanca (Mexico, Atlantic coast)
Tartaruga verde (Portuguese)
Aruana (Brazil)
Krape (Suriname)

f) ***Chelonia agassizi:***[1] Black turtle
East Pacific green turtle
Caguama prieta (Mexico, Pacific coast)

1) The majority of extant texts assume that there are seven valid species of sea turtles in the world. However, a growing body of opinion and evidence recognizes the black turtle of the Eastern Pacific as a full species, ***Chelonia agassizi***, rather than as a subspecies of the green turtle, ***Chelonia mydas***, and this opinion is accepted here. Illustrations of the black turtle are not included in this Manual.

g) ***Chelonia depressa:*** Flatback turtle (Preferred English)
(no common name in Spanish)
Kikila (Daugo Island, Papua, New Guinea)
Usi vidi (Paredaba Village, Central Province, New Guinea)

h) ***Dermochelys coriacea:*** Leatherback (Preferred English)
Tinglada (Preferred Spanish)
Leathery turtle
Trunk turtle (Caribbean English)
Trunkback turtle
Tortue luth (French Guiana)
Coffinback turtle (Trinidad)
Siete filos (Latin America)
Chalupa (Latin America)
Baúla o laúd (Latin America)
Aitkanti (Suriname)
Tartaruga de couro (Brazil)

C.1.2 Identification of Adult and Juvenile Sea Turtles

C.1.2.1 Air Survey Identification

I,II Disc-shaped, virtually as wide as long, medium sized head:
Lepidochelys. Dorsal colouration grey in juveniles, olive green in adults. (Species of *Lepidochelys* can only be identified when in hand; *L. kempi* is restricted to Gulf of Mexico and Northern Atlantic; *L. olivacea* occurs in Pacific, Indian, and South Atlantic Oceans, with rare strays reported from Cuba and Puerto Rico).
Lepidochelys kempi (Kemp's ridley) and
L. olivacea (olive ridley) ..... Figure 1,A

III Heart-shaped or elongate, tapering behind, with strong posterior serrations on carapace in most cases; head narrow and pointed. Carapace brown with variable light radiating markings.
Eretmochelys imbricata (hawksbill) ..... Figure 1,B

IV Somewhat elongate, tapering behind; very large, triangular head; overall colour reddish brown.
Caretta caretta (loggerhead) ..... Figure 1,C

V Nearly oval or somewhat tapering behind; small rounded head. Colour variable – dorsal scutes may be radially streaked, spotted or almost plain.
Chelonia mydas (green turtle) ..... Figure 1,D
Chelonia agassizi (black turtle). .is similar, but darker on the dorsal side (not illustrated).

VI Carapace broadly oval, not tapering behind; head small and rounded. Dorsal colouration yellowish-grey (confined to Northern Australia and adjacent waters).
Chelonia depressa (flatback) ..... Figure 1,E

VII Shell elongate with longitudinal ridges; head medium and rounded; fore flippers very long; overall colour black, variable white spotting; adult size very large – up to 2 metres.
Dermochelys coriacea (leatherback) ..... Figure 1,F

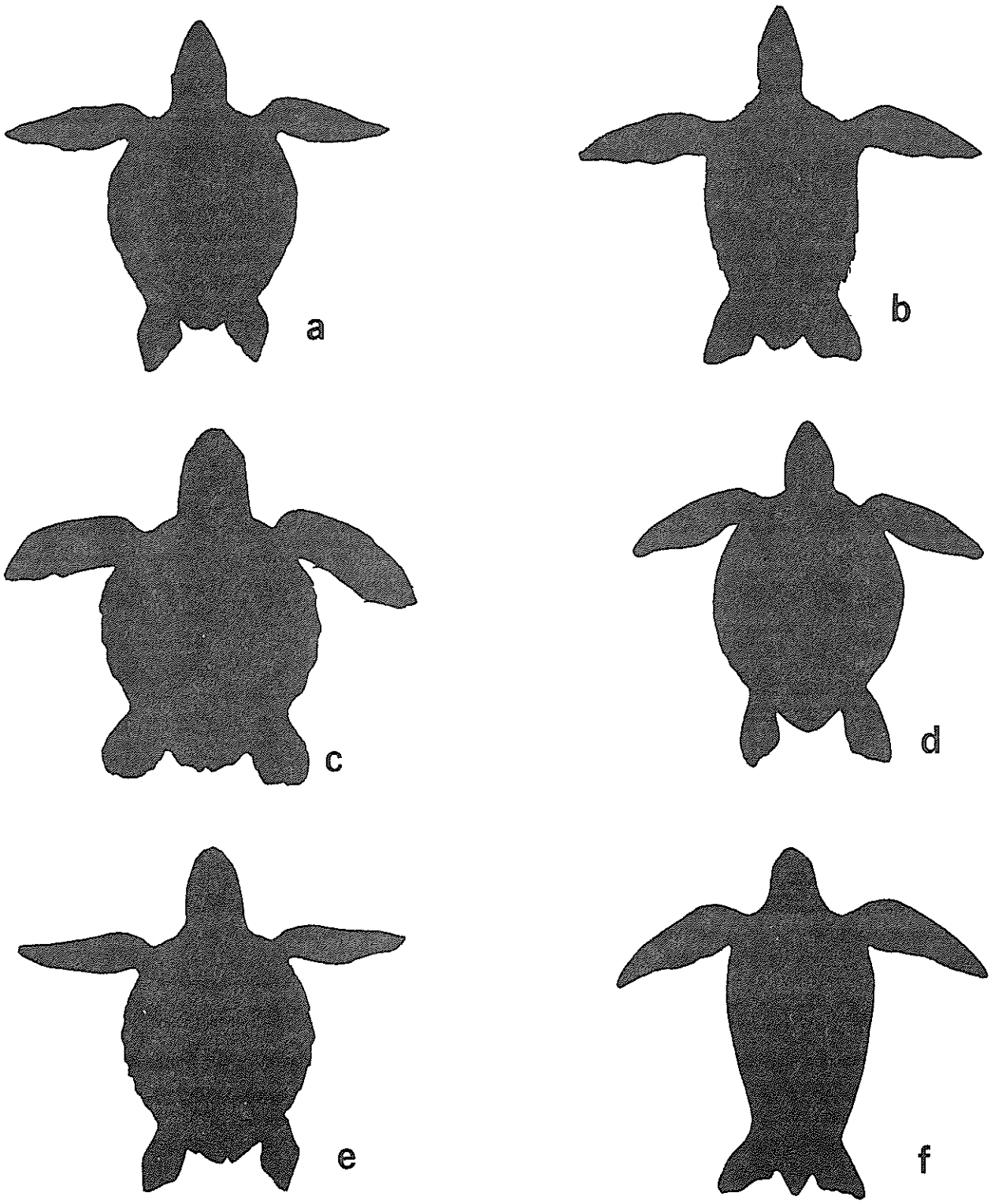


Figure 1. Silhouettes of sea turtles viewed from the air; no relative scale is used. 1,a: ***Lepidochelys kempi*** (Kemp's ridley) and ***L. olivacea*** (olive ridley); 1,b: ***Eretmochelys imbricata*** (hawksbill); 1,c: ***Caretta caretta*** (loggerhead); 1,d: ***Chelonia mydas*** (green turtle); 1,e: ***Chelonia depressa*** (flatback turtle); 1,f: ***Dermochelys coriacea*** (leatherback).

C.1.2.2 **Simplified Key to Species** (Refer to Figure 2, and Coloured Plates 1–32 In Annex I)

1. Leathery shell with seven longitudinal keels, *(Dermochelys coriacea:* leatherback).

1a. Hard shell with horny scutes . . . . . see 2.

2. One pair of prefrontal scales (between eyes and nostrils) . . . . . see 3.

2a. Two pairs of prefrontal scales . . . . . see 4.

3. Three scales behind each eye; carapace with upturned margins, *(Chelonia depressa:* flatback).

3a. Four scales behind each eye; carapace heartshaped without upturned sides, *(Chelonia mydas and Chelonia agassizi:* green and black).

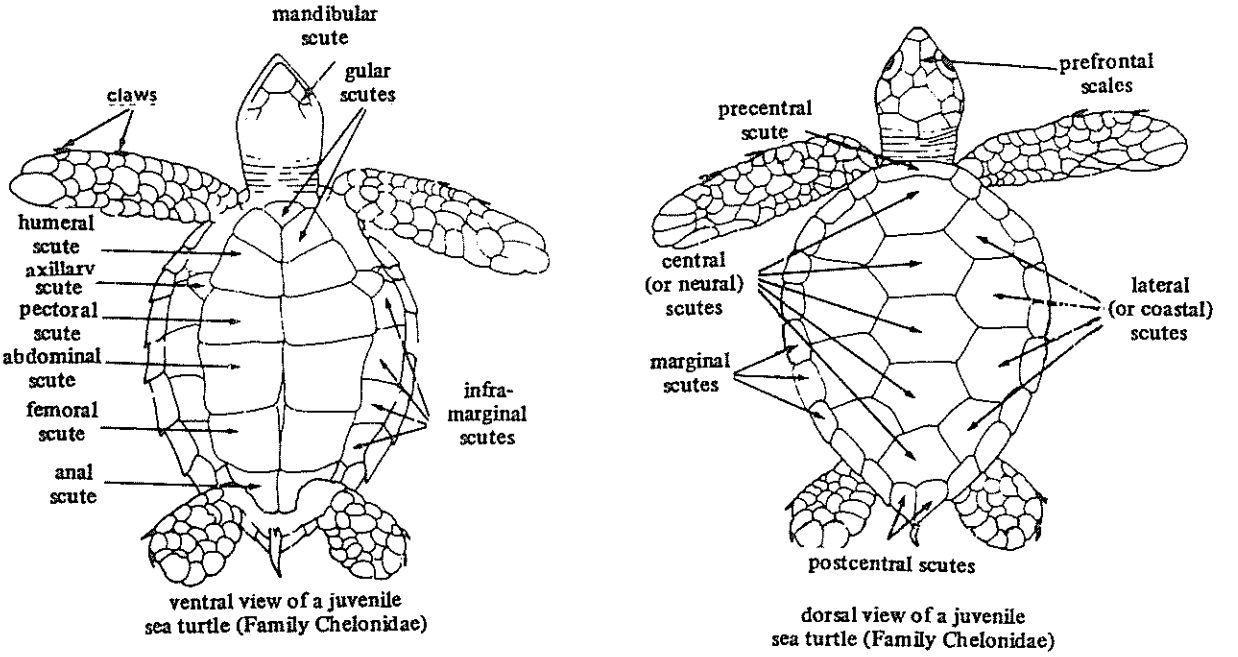


Figure 2. An illustrated guide to morphological terms. *After:* Fischer, W. (Ed.) (1978). *FAO Species Identification Sheets for Fisheries Purposes.* Western Central Atlantic (Fishing Area 31), Vol. VI.

4. Four pairs of large scutes (laterals) on each side of upper shell (carapace), *(Eretmochelys imbricata:* hawksbill).

4a. More than four pairs of lateral scutes . . . . . see 5.

5. Reddish-brown upper body surface; bottom shell (plastron) with three pairs of enlarged scutes (inframarginals) connecting it to the upper shell (carapace), *(Caretta caretta:* loggerhead).

5a. Grey or olive upper body surface; bottom shell (plastron) with four pairs of enlarged scutes (inframarginals) connecting it to upper shell (carapace) . . . . . see 6.

6. Five pairs of lateral scutes on carapace, *(Lepidochelys kempi:* Kemp's ridley).

6a. Six or more pairs (rarely five) of lateral scutes, *(Lepidochelys olivacea:* olive ridley).

C.1.2.3 **Identification of Turtles Available for Close Examination**

In addition to features listed in C.1.2.1, look for the following:

a) Five pairs of lateral scutes. Carapace, up to about 70 cm long (straight-line measurement). Two pairs of prefrontal scutes, Carapace scutes do not overlap. Dorsal colour grey above in immatures, light olive-green in adults. White below in immatures, yellow below in adults. Weight up to about 45 kg.

Lepidochelys kempi (Kemp's ridley).....Figure 3.

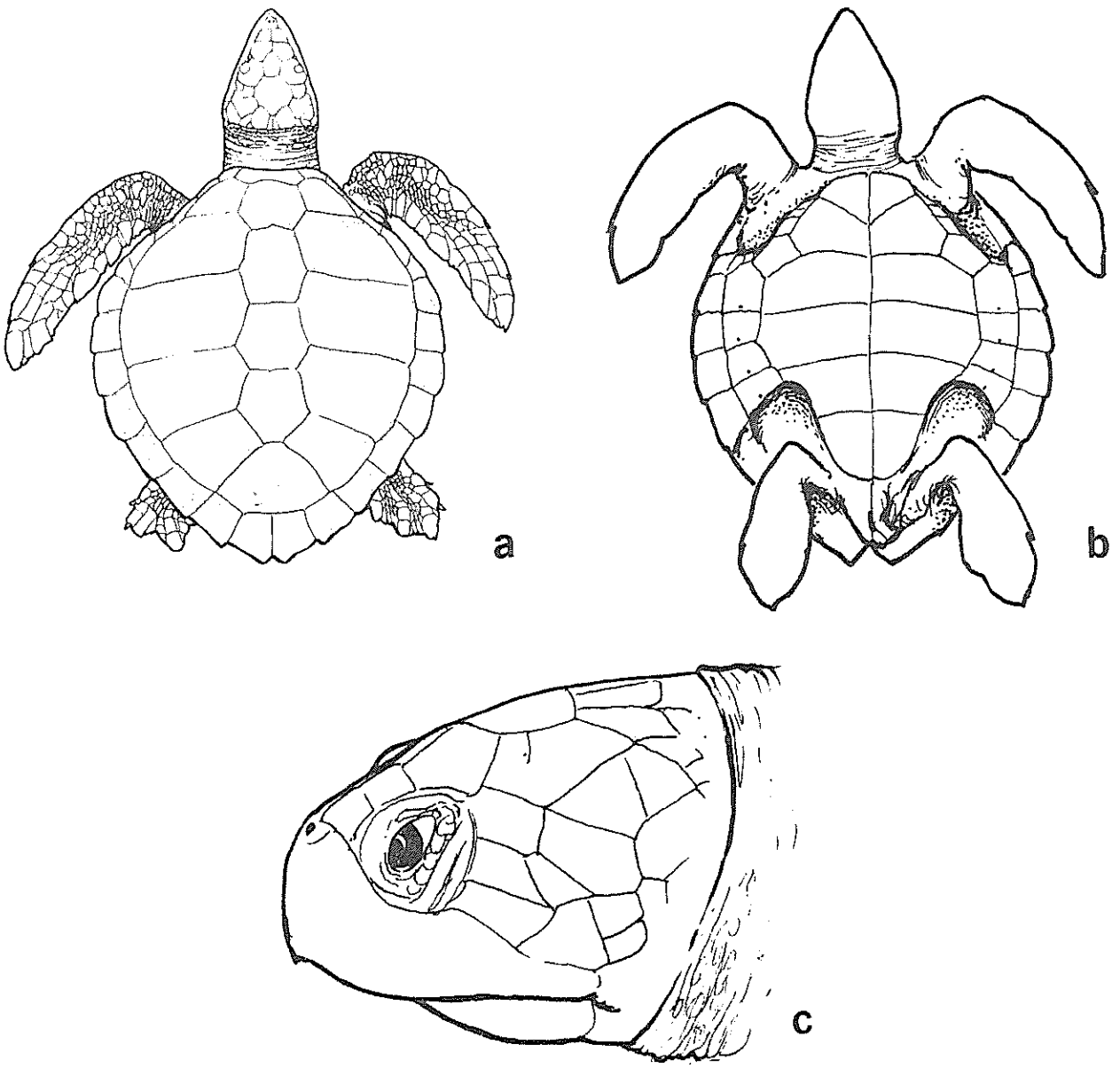


Figure 3. *Lepidochelys kempi* (Kemp's ridley), 3,a: dorsal view; 3,b: ventral view; 3,c: head view.

b) Five to nine pairs of lateral scutes (usually six to eight). Head, up to about 13 cm wide. A pore near the rear of each inframarginal. Carapace, up to 70 cm long. Two pairs prefrontal scutes. Carapace scutes do not overlap. Colour grey above in immatures, dark olive-green in adults. White below in immatures, yellow below in adults. Weight up to about 45 kg.

Lepidochelys olivacea (olive ridley).....Figure 4.

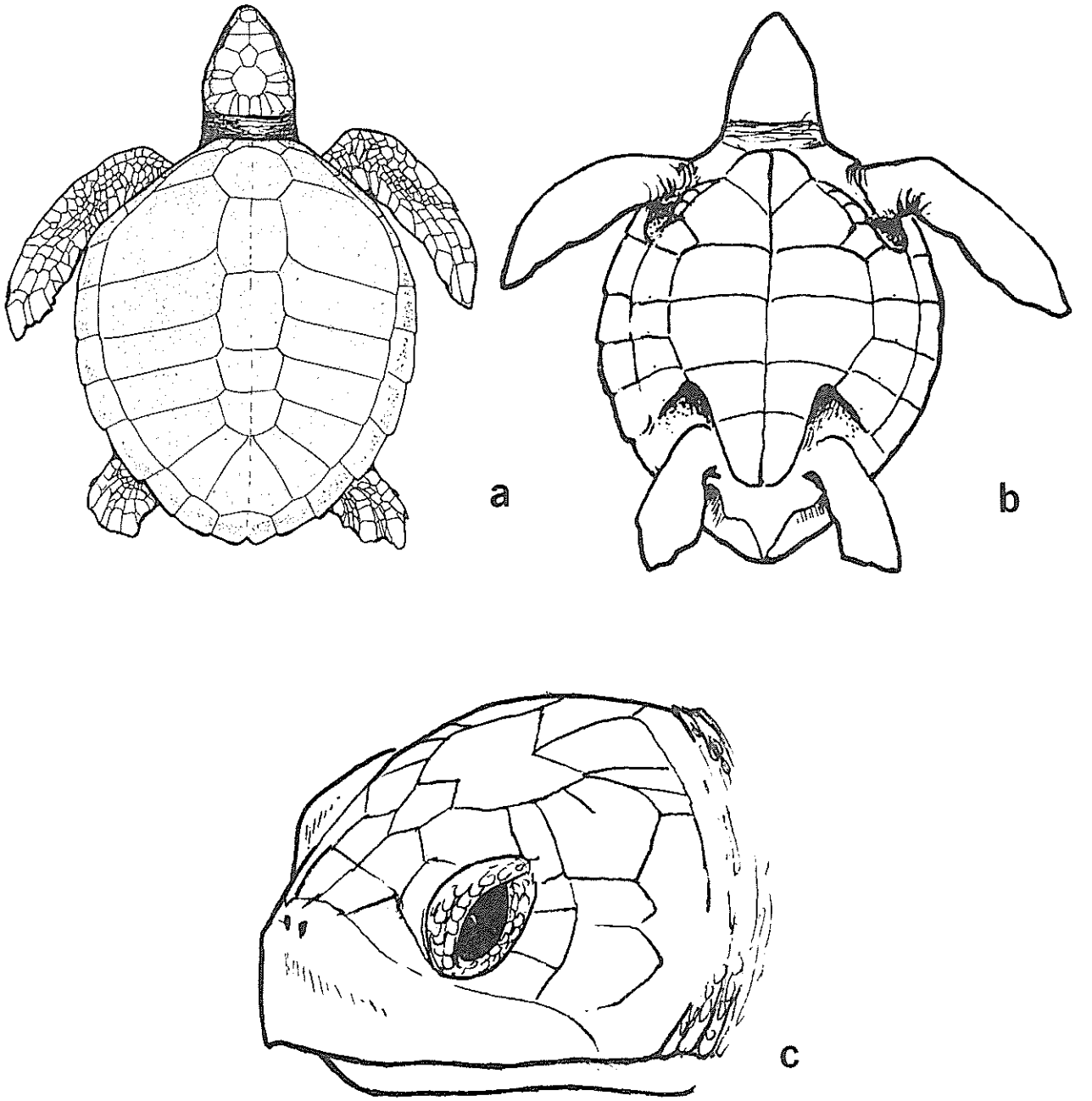


Figure 4. *Lepidochelys olivacea* (olive ridley); 4,a: dorsal view: 4,b: ventral view; 4,c: head view.

c) Four pairs of lateral scutes. Head, up to about 12 cm wide. Carapace, up to about 90 cm long. Two pairs of prefrontal scutes. Carapace scutes thick and overlapping (except in hatchlings and old individuals). Dorsal colour very variable, usually predominately brown with dark and light spots and streaks. Underside light yellow or white, sometimes with black spots (especially in juveniles from Pacific). Weight up to about 80 kg.

Eretmochelys imbricata (hawksbill) .....Figure 5.

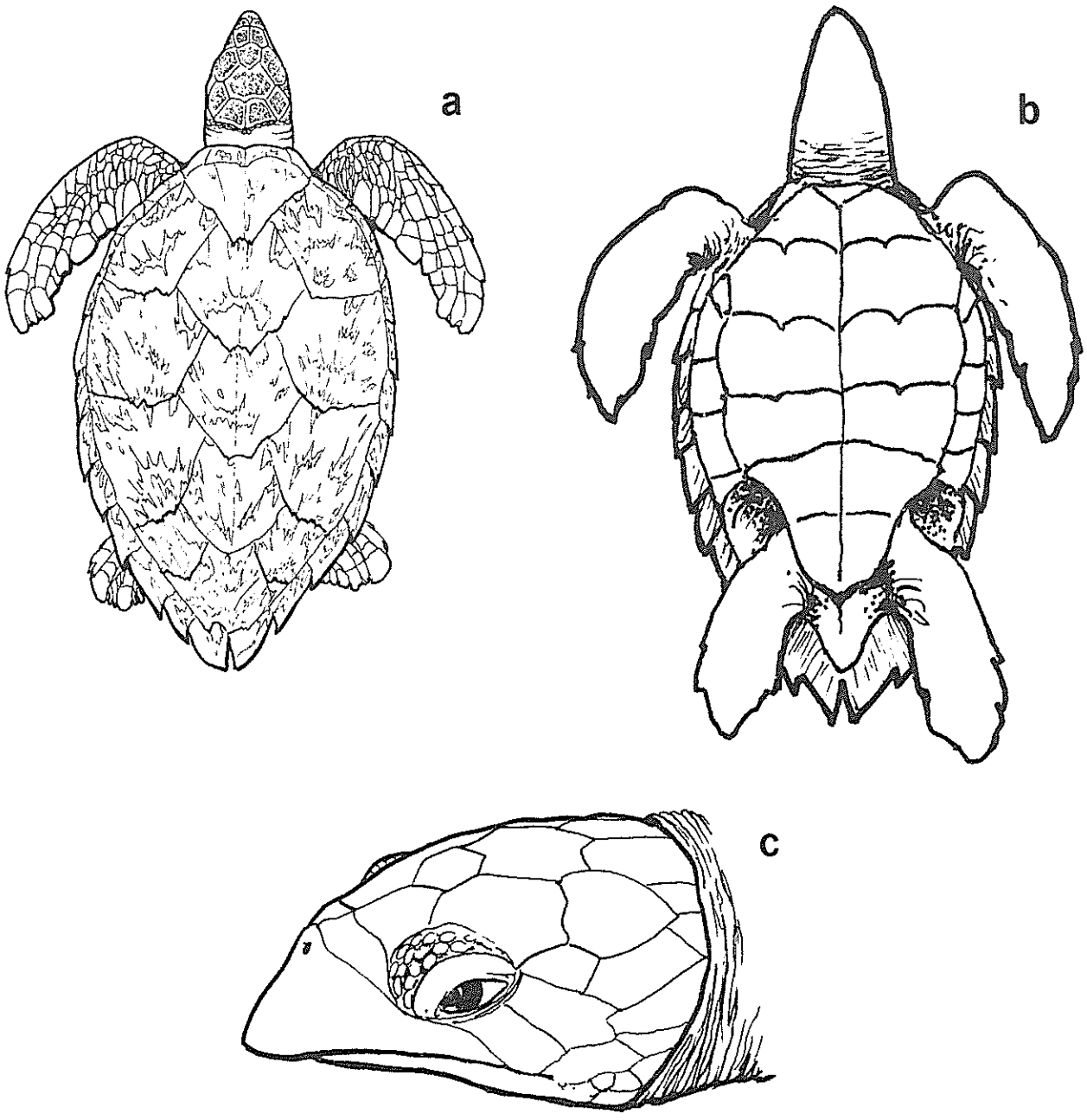


Figure 5. ***Eretmochelys imbricata*** (hawksbill); 5,a: dorsal view; 5,b: ventral view; 5,c: head view.

d) Five pairs of lateral scutes. Head, up to about 25 cm wide. Carapace, up to 120 cm long. Two pairs prefrontal scutes. Carapace scutes not overlapping. Colour reddish-brown above, yellow below. Weight usually up to about 200 kg.

Caretta caretta (loggerhead) .....Figure 6.

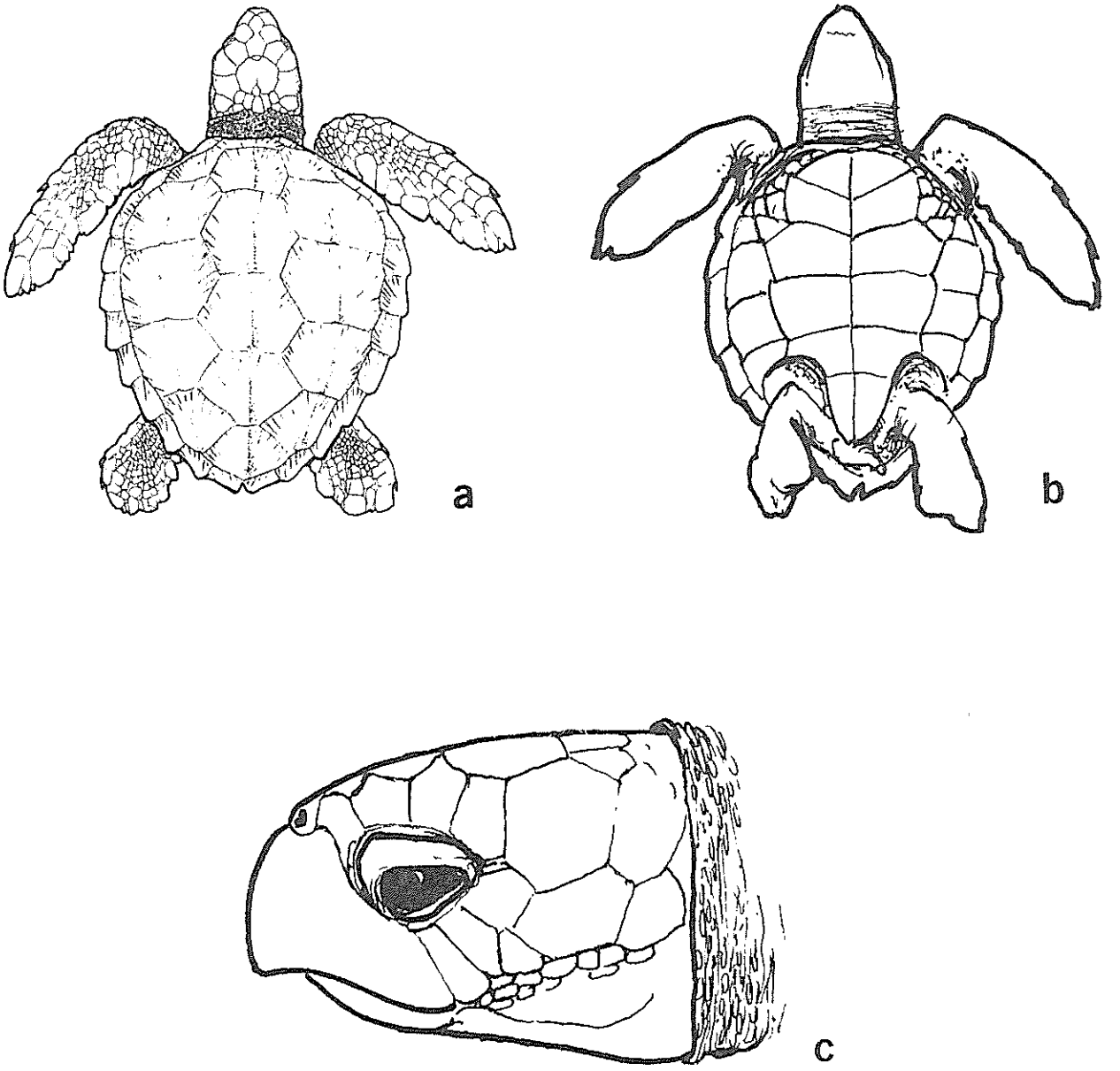


Figure 6. *Caretta caretta* (loggerhead), 6,a: dorsal view; 6,b: ventral view, 6.c: head view.

e) Four pairs of lateral scutes. Head, up to 15 cm wide. Carapace, up to 125 cm long. One pair prefrontal scutes. Carapace scutes do not overlap. Colour varies from light tan to almost black above, often with radiant or spotted markings, underside yellow. Weight up to about 230 kg.

Chelonia mydas (green turtle) .....Figure 7.

f) Four pairs of lateral scutes. Head, to about 12 cm wide. Carapace, up to 100 cm long. One pair of prefrontal scutes. Carapace scutes do not overlap. Colour generally dark, sometimes black without light edges on head scales, underside whitish with variable grey to fuscous, often dense. Weight up to about 100 kg.

Chelonia agassizi (black turtle) .....Not illustrated.

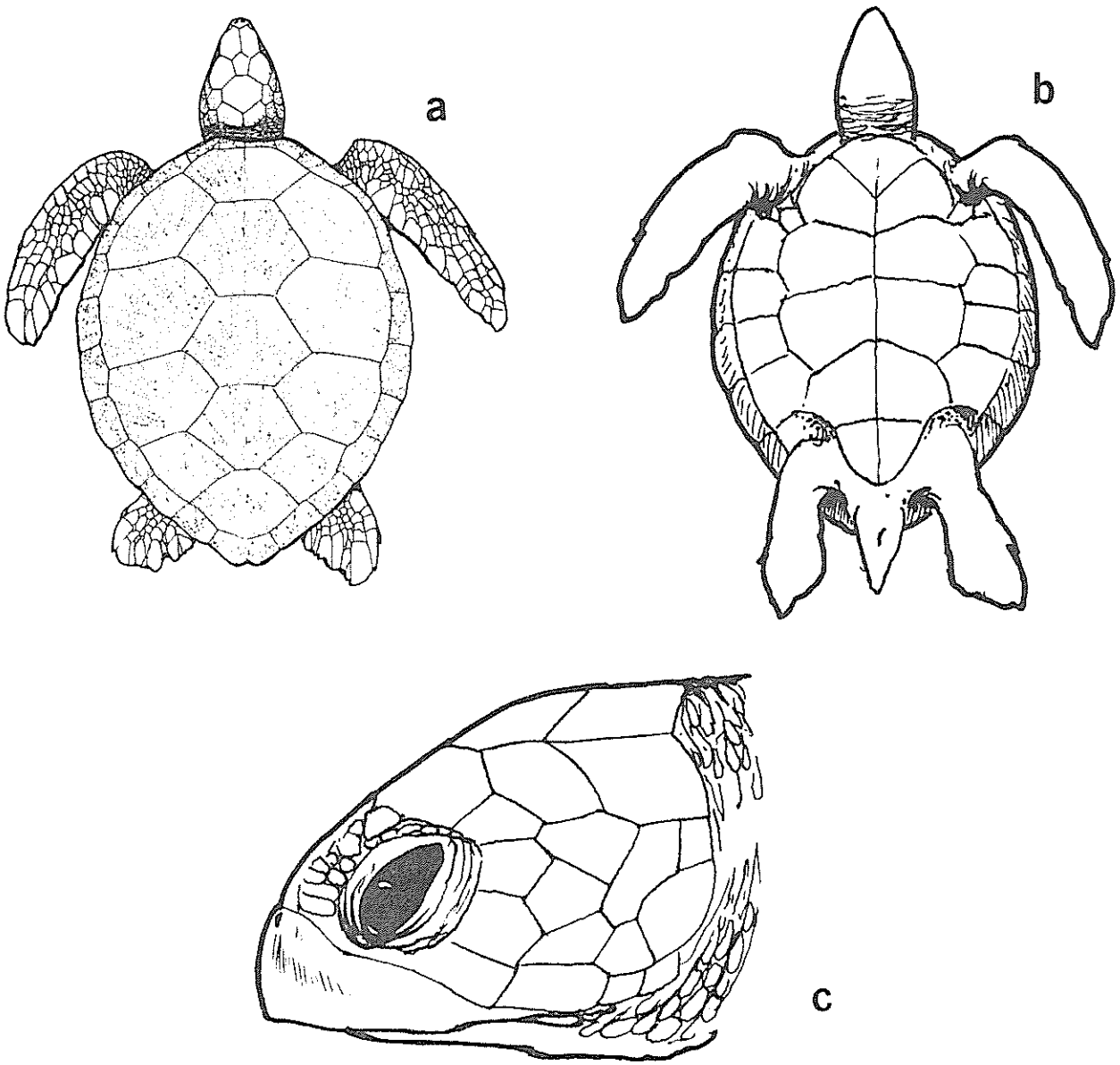


Figure 7. *Chelonia mydas* (green turtle); 7,a: dorsal view; 7,b: ventral view; 7,c: head view.

g) Four pairs of lateral scutes. Head, up to about 13 cm wide. Carapace, up to 100 cm long. One pair prefrontal scutes. Carapace scutes do not overlap, very thin, with indistinct margins, especially in adults. Dorsal colour yellow-grey to grey-green, without spots or radiating markings; underside light yellow. Weight up to about 90 kg.

Chelonia depressa (flatback) . . . . . .Figure 8.

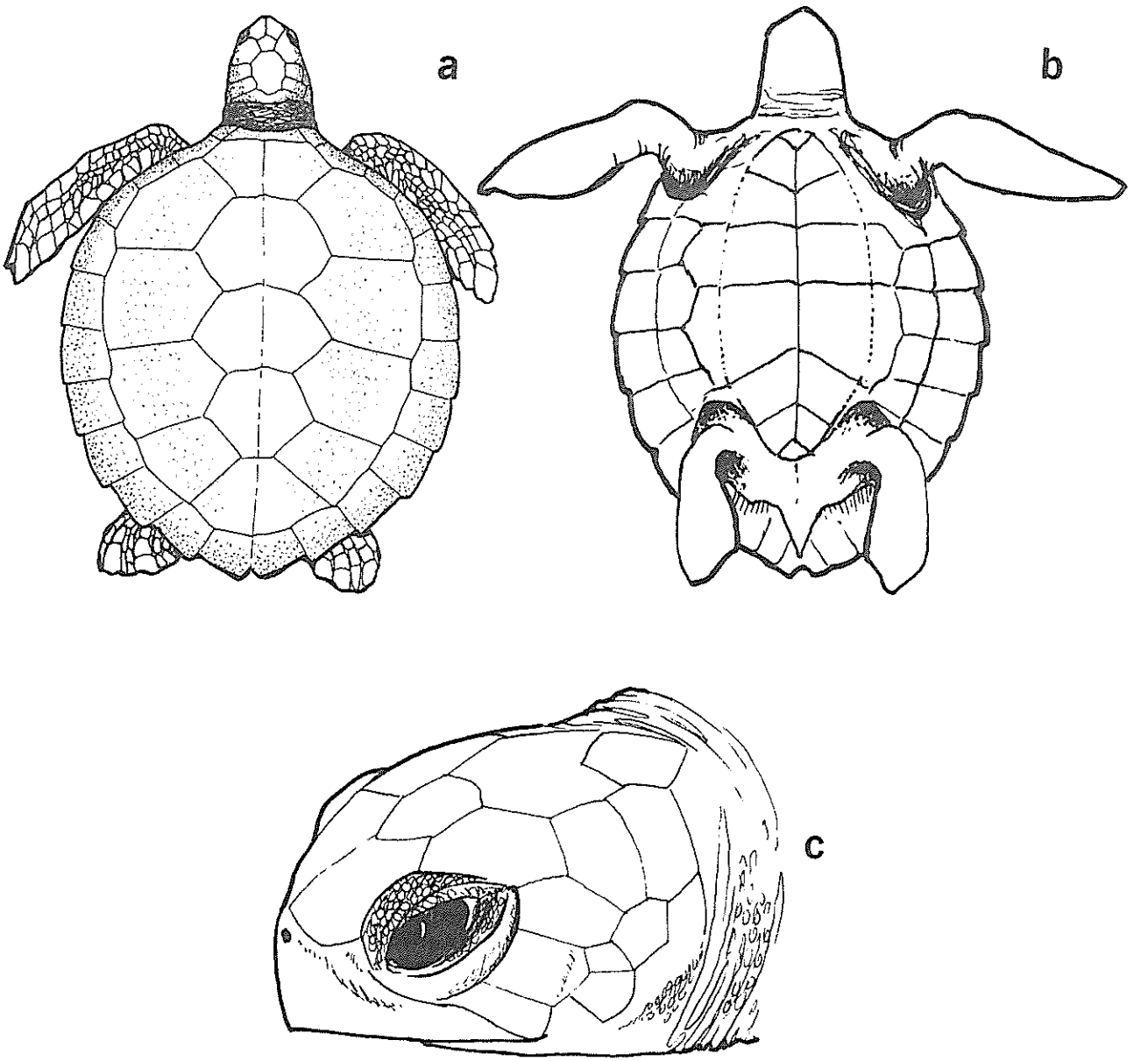


Figure 8. *Chelonia depressa* (flatback); 8,a: dorsal view; 8,b: ventral view; 8,c: head view.

h) Carapace with seven longitudinal ridges, no scutes at all. Head, up to about 25 cm wide. Carapace, up to about 190 cm long. Head and flippers covered with unscaled skin. Dorsal colouration predominantly black, with variable degrees of white spotting. Spots may be bluish or pink on neck and base of flippers. Underside similar but with light rather than dark areas. Weight to about 600 kg.

Dermachelys coriacea (leatherback) .....Figure 9.

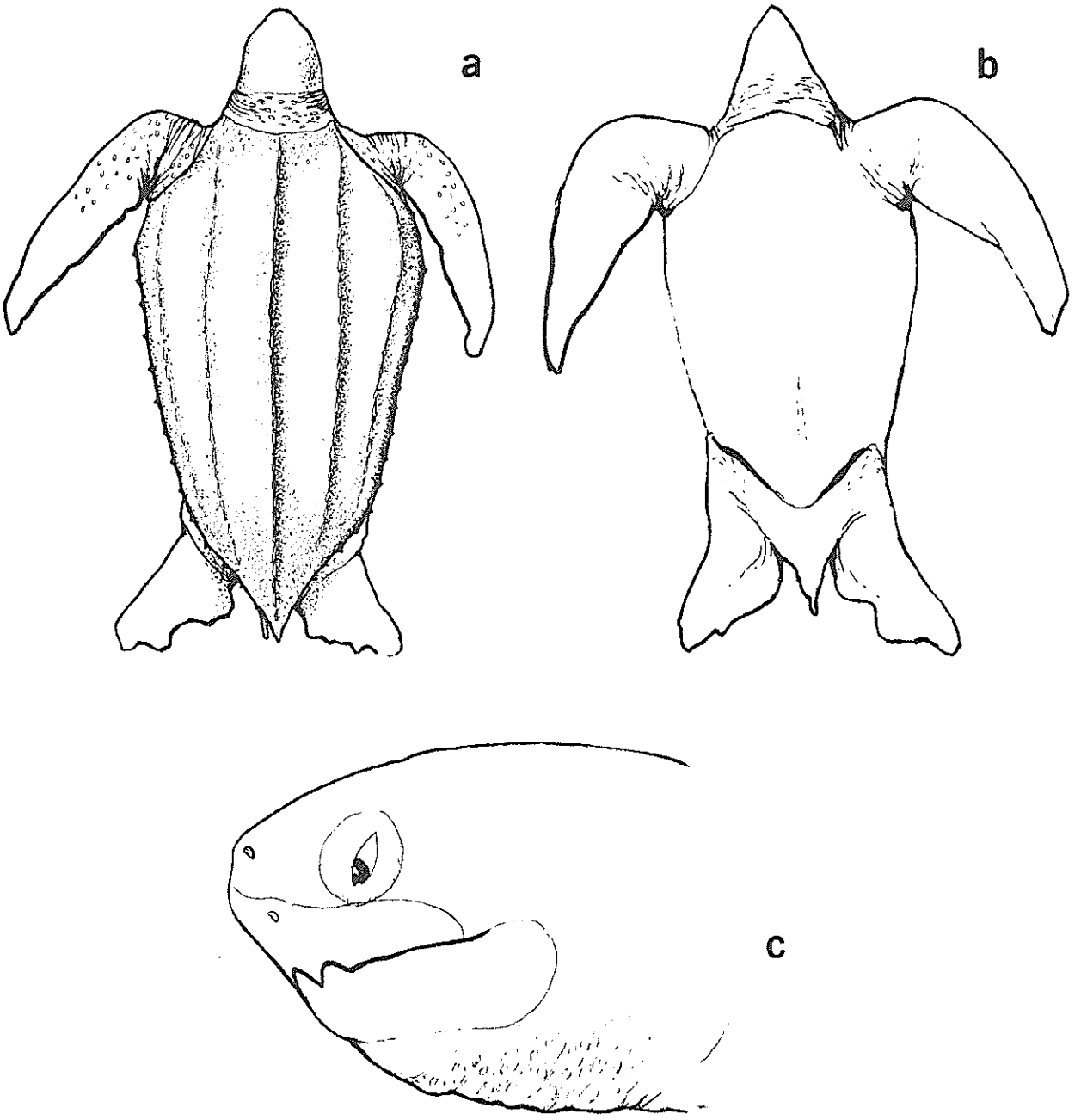


Figure 9. *Dermochelys coriacea* (leatherback), 9,a: dorsal view; 9,b: ventral view; 9,c: head view.

C.1.3 Identification of Hatchlings

For reasons still somewhat obscure, hatchling turtles are rarely encountered at sea. They may be found, however, on nesting beaches. Sometimes they are blown onto other beaches by storms. The young turtles usually dig out of the nest at night, emerging nearly simultaneously on the sand's surface and proceed rapidly to the sea. But some die (killed by birds, exposure to sun, etc.) on the beach. Therefore, surveyors who visit a nesting beach during the day in season can usually identify species and collect specimens of dead hatchlings.

Hatchling turtles may be identified according to instructions for identification of a turtle in hand, because hatchlings' scale and scute counts match those of adults (though with perhaps a higher percentage of abnormal variations than the adult pattern). In addition to Colour Plates 1–32, Annex I, the following points will assist in hatchling identification:

I. Hatchling ridleys of both species are very dark grey or black both above and below. They may be differentiated from each other only by the lateral scute count (five pairs in *L. kempi*, usually six to eight or nine pairs in *L. olivacea).*

II. Hatchling loggerheads and hawksbills are both brown above and below (shade varying from light to dark). The two species look very similar as hatchlings, but may be differentiated by the lateral scute count (five pairs in *Caretta*, four pairs in *Eretmochelys).*

III. Hatchlings of the three species of *Chelonia* are the only ones with a white plastron. Hatchling *C. depressa* is substantially larger than hatchling *C. mydas* and *agassizi*, has an oval rather than posteriorly tapering carapace, turquoise rather than black eyes, three rather than four scutes behind each eye (postorbital scutes), and a yellow rather than grey band around the underside of the marginals.

IV. Hatchling leatherbacks are unmistakable. The longitudinal shell ridges are already present, the fore flippers are extremely long (almost as long as the carapace), and the entire skin of the animal, shell and soft parts is covered with small, soft, polygonal scutes.

C.1.4 Identification of Tracks and Nests

Two typical sea turtle nesting positions are illustrated in Figure 10.

Figure 10. Two typical nesting positions of sea turtles.

C.1.4.1 Species Track and Nest Descriptions

Different kinds of sea turtle tracks are diagrammed in Figure 11.

a. **Green sea turtle:** *(Chelonia mydas)*

Track width: typically about 1 metre.

Type of track: deeply cut, with symmetrical diagonal marks made by the front flippers.

Preferred beach type: generally large, open beaches, but exceptions are known (e.g., in the Galapagos Islands, where very small beaches may be heavily used).

Number and size of eggs: clutch size very variable, averaging less than 85 eggs in the east Pacific (Mexico, Galapagos), and sometimes more than 200 in the south Atlantic (Suriname, Ascension Island). Egg diameter between 4 and 5.5 cm.

Geographic location of nesting beaches: large colonies may nest both on mainland beaches or remote oceanic islands. Tropical beaches preferred; northern limit of regular nesting is Florida and northern Mediterranean in the Atlantic area.

b. **Black sea turtle:** *(Chelonia agassizi).*

Track width: typically about 90 cm.

Type of track: as for green turtle but less deeply cut.

Preferred beach type: wide, not steeply shelving, often enclosed between rocky headlands.

Number and size of eggs: usually 80 or fewer, about 4 cm in diameter.

Geographic location of nesting beaches: eastern Pacific, both mainland (Mexico, Costa Rica) and islands (Galapagos and Revillagigedos).

c. **Flatback sea turtle:** *(Chelonia depressa).*

Track width: about 90 cm.

Type of track: relatively lightly cut, with symmetrical diagonal marks made by the front flippers.

Preferred beach type: fairly large open beaches, on mainland or large islands; reef habitat avoided.

Number and size of eggs: average clutch only about 50 eggs (maximum 73). Eggs average about 5 cm in diameter.

d. **Loggerhead sea turtle:** *(Caretta caretta).*

Track width: 90 to 100 cm.

Type track: moderately deeply cut, with alternating (asymmetrical) diagonal marks made by the front flippers.

Preferred beach type: generally extensive mainland beaches and barrier islands; moderately steep beach profile preferred.

Number and size of eggs: average clutch approximately 120 eggs. Average egg diameter approximately 4 to 5 cm.

Geographic location of nesting beaches: subtropical sites preferred, e.g., southeastern United States (Atlantic, more than Gulf coasts); southern Brazil; Japan; South Africa; temperate Australia. However, some tropical nesting areas are known, including Pacific Panama and Caribbean Colombia. Rarely, if ever, nests on oceanic islands.

e. **Kemp's ridley sea turtle:** ***(Lepidochelys kempi).***

Track width: typically about 80 cm.

Type of track: very shallow, with alternating (asymmetrical) diagonal marks made by the front flippers. Usually obliterated because nesting takes place during high winds. Nests in daytime.

Preferred beach type: nests exclusively in the western Gulf of Mexico, with almost all nesting concentrated on a few miles of beach in southern Tamaulipas State (Rancho Nuevo), where the beach is continuous for hundreds of miles; moderate energy, low tidal amplitude, with well-vegetated dunes and associated marshes.

Number and size of eggs: clutch size average about 105 eggs. Average egg diameter 4 to 4.5 cm.

Geographic location of nesting beaches: see above ("Preferred beach type").

f. **Olive ridley sea turtle:** ***(Lepidochelys olivacea).***

Track width: typically about 80 cm.

Type of track: very shallow, with alternating (asymmetrical) diagonal marks made by the front flippers. Nesting at night except during massive "arribadas" when nesting also may occur in daylight hours.

Preferred beach type: variable; almost always on mainland tropical shores with lightly vegetated or unvegetated berm areas.

Number and size of eggs: clutch size average about 100 eggs. Egg diameter from 3.2 to 4.8 cm.

Geographic location of nesting beaches: mainland tropical shores of Pacific, Indian and South Atlantic Oceans, with high concentrations in certain limited areas on Pacific coasts of Mexico and Costa Rica, also Suriname and India. No nesting known outside tropics or on oceanic islands.

g. **Hawksbill sea turtle:** ***(Eretmochelys imbricata).***

Track width: typically about 75 to 80 cm.

Type of track: shallow, with alternating (asymmetrical), diagonal marks made by the front flippers.

Preferred beach type: exclusively tropical, often nesting on small beaches on coral islands where no other species is known to nest; also nests on beaches on granitic islands (Seychelles) and limestone islands (Mona). However, small numbers may nest on large mainland beaches heavily used by other species.

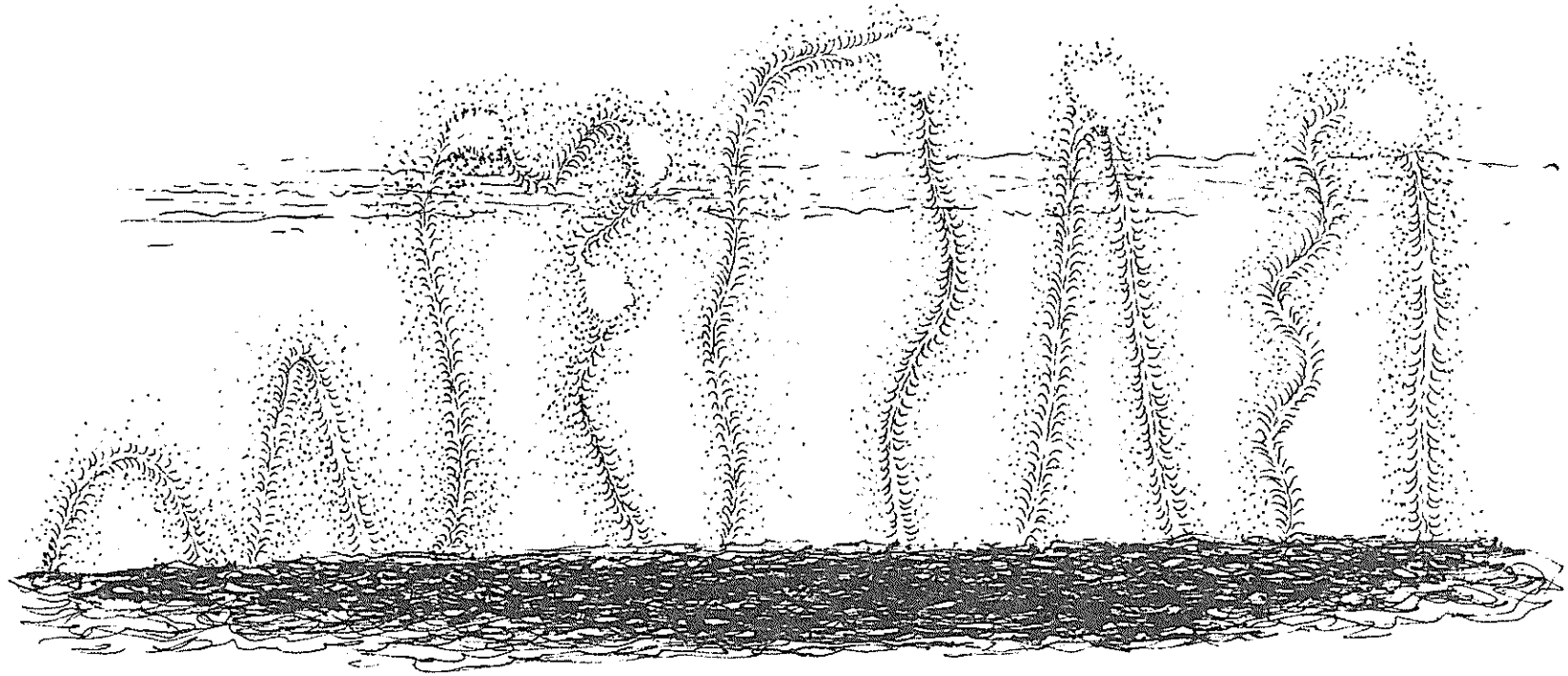


Figure 11. Various types of sea turtle crawl tracks and nest marks to be seen on sandy beaches.

Nests and tracks are hard to distinguish from those of ridleys, but the two generally have different beach-type preferences and rarely nest together. Also, hawksbills frequently nest under overhanging vegetation, unlike ridleys which nest in open areas. Hawksbills often wander extensively before nesting.

Number and size of eggs: clutch size variable, often high; known range 53 to 250 eggs, average 161 in Caribbean, 182 in Seychelles. Egg diameter 3.6 to 4.2 cm (average 3.8 in the Caribbean).

Geographic location of nesting beaches: tropical shorelines of Atlantic, Pacific, and Indian Oceans.

h. *Leatherback sea turtle: (Dermochelys coriacea).*

Track width: 1.5 to 2 metres.

Type of track: very deep and broad, with symmetrical diagonal marks made by the front flippers usually with a deep incised median groove formed by dragging the relatively long tail.

Preferred beach type: large, long, tropical beaches with a considerable slope and unobstructed deep water approach.

Number and size of eggs: clutch size averages about 85 eggs, usually less than 120, not including a variable number of yolkless undersized eggs found in every nest. Fullsize eggs 6 to 6.5 cm in diameter.

Geographic location of nesting beaches: nests usually in colonies on isolated mainland beaches in all tropical oceans. Rarely nests outside tropics or on islands, although nesting is known in the Caribbean on many of the Greater and Lesser Antilles, becoming regular in a few places (e.g., St. Croix).

C.1.4.2 The Age of the Track. Fresh Crawls and Old Crawls.

For survey purposes, it is desirable to distinguish between fresh crawls and old crawls. A *fresh crawl* is defined as one made within 24 hours of the survey. An *old crawl* is one made more than 24 hours previously.

If a survey is made early in the morning, fresh tracks made the previous night are often identifiable as such. The marks are crisp and clear and extend to the surf-line. The first high tide or heavy rainfall after nesting, or the nesting of later turtles, will obscure the lower part of the tracks. Knowing the time of high tides or of recent rain can help in estimating the age of tracks. Wind gradually obscures tracks and nest sites on the upper, drier parts of the beach, so that old marks have less sharp edges and generally disappear altogether.

C.1.4.3 Whether Nesting was Successful. Nesting Crawls and False Crawls.

Usually a sea turtle crawl is a nesting crawl — one that results in digging a nest and laying the eggs. But sometimes a sea turtle crawls without nesting. This is a false crawl, indicated by a "half-moon" track. To survey and monitor nesting success, it is important to distinguish between nesting crawls and false crawls.

False crawls generally fall into one of three categories. If the turtle intended to nest but was disturbed, the track may be sharply angular. If the turtle did not intend to nest, the track may be crescent-shaped. If the turtle started to dig but abandoned the nest after one or two attempts, she frequently leaves irregular track marks and signs of superficial digging. On some crawls, one or more false nests may precede the preparation of a final nest. These can be easily distinguished from the simpler, more definite successful nesting sites (See Figure 11).

C.1.5 Species Identification Problems

Individual turtles may prove difficult to identify for any of the following reasons:

C.1.5.1 Barnacles or other attached organisms may hide features critical for identification. Loggerhead and hawksbill turtles, especially old ones, are most likely to be heavily infested with barnacles and other adhering organisms. Leatherbacks and ridleys of both species are never heavily fouled with barnacles, etc., although many adult ridleys do carry isolated barnacles on the shell and sometimes the top of the head. Typically free of large barnacles, green turtles' shells are quite clean, although occasionally, especially in protected lagoons, a few are found with moderate to heavy barnacle accretion. The black turtle may be heavily encrusted with barnacles. Flatback turtles carry few barnacles.

Even badly fouled turtles can be identified on the basis of overall size, shape, relative head size, etc. Surveyors can distinguish a heavily encrusted loggerhead from a hawksbill, for instance, because it has a much wider head. And the hawksbill's overlapping scutes are seldom totally obscured by barnacles.

C.1.5.2 All turtle species show a certain frequency of deviations from the standard scute and scale counts given in the identification guide (C.1.2) . The scute counts of the olive ridley are so variable that there is no typical pattern for this species. Lateral scute counts cited for the other species characterize the vast majority of individuals. It is not uncommon, however, for variations to occur. For example, any of the hard-shelled sea turtles may show a small extra central scute between the fourth and fifth centrals; occasional green turtle and hawksbill specimens may have more than four laterals on each side. Even in such cases, the extra scutes seldom take the form of the additional lateral scutes that is normal for the loggerheads and ridleys. In the ridleys, the first lateral is relatively small, followed by four much larger scutes which diminish posteriorly. Rare loggerhead specimens missing the small first lateral scutes may be more confusing. However, such specimens still show typical characteristics of colour, body shape and proportions, and can be identified with a little experience.

Specimens that, after exhaustive study, appear not to be clearly referable to any single species should either be retained (dead or alive), or photographed from all angles in close detail for subsequent study by an expert before release.

C.1.5.3 Some turtles found in a marine or estuarine environment are not true sea turtles; several species of freshwater (river or marsh) turtles may enter the sea by accident. Also, salt or brackish waters are the normal habitat of certain freshwater species during part of their life cycle.

Generally, sea turtles can be distinguished from freshwater species by their forelimbs. True sea turtles have flattened fore flippers in which the individual digits are obscured and show no independent movement (Figure 12, a). They usually have a single claw on each fore flipper; a second claw, if present, is very small. The leatherback has no claws at all.

Most freshwater turtles have five claws on each forelimb or "foot", with the individual digits easily distinguishable, even if partly or fully webbed (Figure 12,b). Soft-shelled turtles' forelimbs are part-way between "feet" and "flippers", but the three claws on each foot are well-defined.

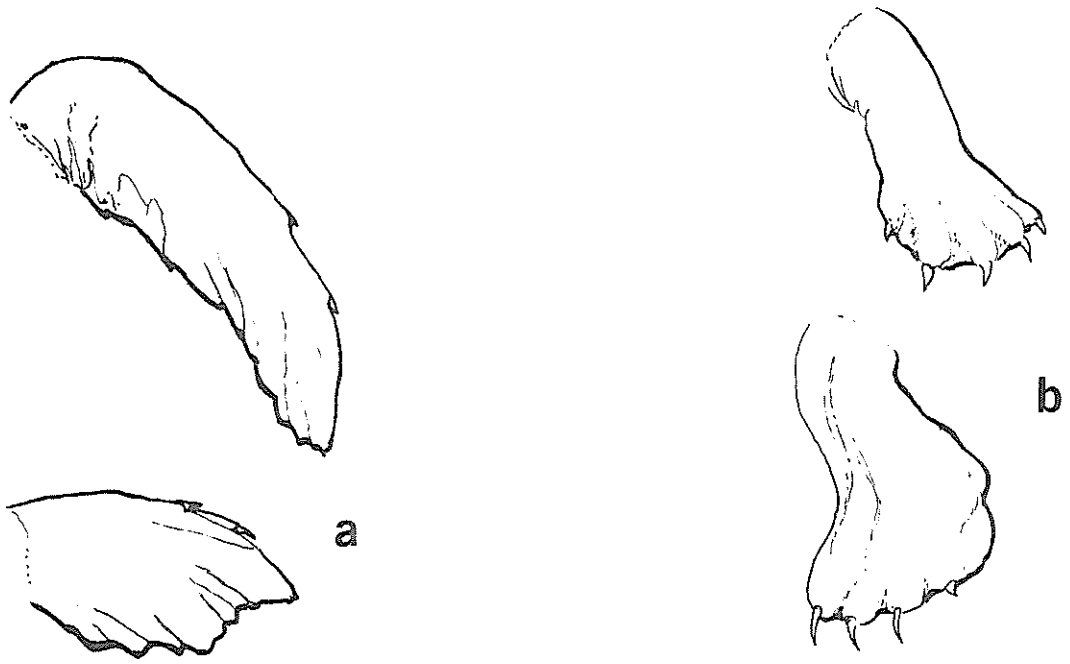


Figure 12. Turtle limbs. 12,a: Sea turtle forelimb and hindlimb; 12,b: Freshwater turtle forelimb and hindlimb.

Some of these freshwater species are not well known, especially in tropical regions. Therefore, recording their presence during sea turtle surveys is useful. Some freshwater species found from time to time in the marine environment are:

1. *Malacleyms terrapin* (diamonback terrapin). Range: U.S.A. Atlantic and Gulf Coast from Cape Cod to southern Texas. Maximum size about 20 cm.

2. *Pseudemys concinna suwanniensis* (Suwanne turtle). Range: U.S.A. Gulf drainage of Florida from Tampa area to Western Florida, most abundant in the Suwannee River itself. Size: females up to 43 cm carapace length, males about 33 cm.

3. *Podocnemis expansa* (Orinoco River turtle, arrau turtle). Range: Orinoco and Amazon River systems of South America. Regularly carried to Trinidad by the Orinoco in flood. Size: adult females average about 66 cm, maximum about 80 cm.

4. *Trionyx triunguis* (Nile soft-shelled turtle) Range: Nile drainage, much of Africa, parts of the eastern Mediterranean countries. Only known to enter the marine environment in the eastern Mediterranean. Apparently a normal part of the marine fauna off Turkish coast. Size: Carapace length up to about 80 cm.

5. *Pelochelys bibroni* (giant soft-shelled turtle). Range: from the Malaysian Peninsula and Thailand, through Indonesia and the Philippines, to New Guinea. Size: reputed to exceed 120 cm carapace length; usually much smaller, but specimens over 70 cm are common.

6. *Carettochelys insculpta* (plateless river turtle). Range: Fly River and associated drainages in southern New Guinea; Daly River and a few other rivers in the Northern Territory, Australia. Found on occasion in the Arafura Sea and the Gulf of Carpentaria. Size: Carapace length up to 50 cm.

7. *Callagur borneoensis* and *Batagur baska* (Asiatic river turtles), "tuntong sungai" and "tuntong laut"; these two rather similar species are often confused, though the colouration in breeding season, especially of males, is distinct. Range: Souther Thailand, Peninsular Malaysia, Borneo (only *Callagur)* and Sumatra. Size: females of both species are commonly 60 cm in length; males are smaller, 30-35 cm.

C.1.5.4 On rare occasions, sea turtle species hybridize.

C.2. Aerial Surveys

Aerial Surveys are the fastest and, sometimes the least expensive way to document potential or active turtle nesting beaches and to obtain data on sea turtle population, distribution and activities in an extensive area. However, because neither beach nor pelagic aerial survey techniques have been perfected, results must be carefully interpreted, and qualified whenever necessary. Moreover, surveyors must take care to record their observations in a standarized format so that data from different times, areas, and recorders are as compatible as possible for broad-scale comparison, integration and analysis. Recommended survey procedures are described below.

C.2.1 Beach Aerial Surveys

The main purpose of *Beach Aerial Surveys* is to provide data critical to estimate an area's turtle population. The acute gaps in sea turtle biology and the present inadequacy of survey techniques mean that populations must be gauged indirectly, based on the estimated number of nesting females in an area annually.

To make this estimate, the *Beach Aerial Survey* must record the number of sea turtle crawls (tracks) on beaches within specifically defined shoreline zones. The tracks are counted while the plane flies at a relatively low altitude (about 150 to 400 feet), at a relatively slow speed (from 75 to 90 knots), about 50 to 150 feet off the shoreline (at about a 45° viewing angle).

Secondary objectives of *Beach Aerial Surveys* are to observe and record: turtle carcasses; any activity that might interfere with sea turtle nesting, incubation or hatchling emergence; and any turtle activity in the water along the shoreline.

When a *Beach Aerial Survey* is being flown along a shoreline of an area (country, state or other unit) that has not been documented previously, geographic features (such as cliffs or sand beaches) must be recorded. This will allow flight paths for later surveys to be planned more efficiently.

Because observers walking or riding along a beach can count crawls more accurately than aerial observers, *Ground Truth Surveys* (C.2.2) of nesting beaches should be made on the day of the aerial survey, if possible. These ground survey counts can indicate and correct for any aerial calculation error. As explained later in this Manual, the *Ground Truth Survey* should cover one entire zone of air survey.

C.2.1.1 Aircraft

A high-wing, single-engine four-seat aircraft is recommended for *Beach Aerial Surveys* because it affords optimum observer facilities. Two- or three-seat aircraft will do. Six-seat multiple engine aircraft are more expensive to operate. Helicopters, if available are most useful, but very expensive.

C.2.1.2 Considerations for Aircraft Charter

A trained, capable pilot is essential for a successful survey. The following suggestions may eliminate some safety and logistical problems encountered in the past, especially when a plane and pilot are chartered for the first time.

Before the flight, determine the flying time, the plane's fuel capacity and survey costs. Check the pilot's safety record and his ability to make tight maneuvers. Be sure that he can maintain and continually inform recorders of his location (with respect to their charts). Determine the flight path, the plane's speed capability (slowest and cruising), its minimum altitude; be aware of any in-flight restrictions created by altitude, the height and distances off all shorelines. Investigate local weather and aerial conditions such as updrafts that might interfere with the survey. Consult pilot about overwater flight conditions when surveying offshore islands. Determine possible landing strips along the route, and obtain prior authorization to enter any restricted areas that the survey zone might encounter.

C.2.1.3 Personnel

Four persons are ideal: a pilot, two observers and a recorder. The pilot usually sits left-front and continually informs observers/recorders of location, landmarks, time, weather conditions, and changes in speed or altitude. The survey should be flown just seaward of the shoreline.

The two observers sit right-front and right-rear. They should make independent observations and counts and both sets of observers sightings should be recorded to evaluate accuracy. However, on initial or infrequent flights, especially with inexperienced observers, surveyors should compare and confirm observations as they occur.

The recorder sits left-rear, records all events the observers and pilot report and watches, when possible, for sea turtle activity in the water on the left. With only three persons, the recorder sits right-rear and assists in observations whenever possible. With only two persons, the observer sits at right-front and doubles as recorder.

Training and experience are most important. As aerial surveys become more refined and sophisticated, observer reliability should be assessed and factored into the results.

C.2.1.4 Equipment and Supplies

These are minimal. Data recording forms are discussed below. For surveys of unfamiliar areas, observers and recorders need a standard set of maps, with shoreline *zones* and *landmarks* previously determined whenever possible. The maps should be cut and arranged to facilitate easy in-flight reference. Personnel should be familiar with the maps and landmarks before the survey flight begins. Where turtle crawls are abundant, each observer should use a hand-held event counter. At each landmark, the recorder should take the used counter from the observer, record the tally and provide the observer with a fresh counter. Or, a reliable hand-held tape recorder may be used, especially when no second person is available as data recorder. The tape recorder should be tested before take-off and again in flight before recording observations to be sure the replay can be understood over cabin noise. Watches should be synchronized before departure. Polarized sun glasses are very useful. High-speed photography may be used to document certain events, especially frequent changes in shoreline types.

C.2.1.5 Time of Survey

The best time to survey a beach from the air is early morning unless shadows from vegetation obscure visibility. Observers can see tracks most clearly from the time the sun first strikes the beach until about 10:00 a.m. After that, the higher angle of the sun frequently makes observations of the beach more difficult. Light coloured sand beaches become too bright for accurate counting and the shadows cast by the turtle tracks lessen, making the tracks less conspicuous. Track depressions in the dry sand become less visible, so fresh tracks are harder to discern.

As the sun begins to set in late afternoon, or when it no longer directly strikes the beach, the tracks become visible again. The survey can be resumed then, although afternoon conditions are seldom as good as those in early morning.

C.2.1.6 Weather and Tides

Day-to-day knowledge of ocean tides and weather conditions should be maintained throughout the survey period. Knowing when the tides occur and the approximate time of most recent rainfall can help in interpreting the age of crawls being counted. On some beaches, for example, a high tide occuring late at night will erase all tracks made previously on the intertidal part of the beach and only tracks made by turtles that nested after the high tide will be visible. Rainfall or high winds can also obliterate recent and/or old crawls. Although not proven in all areas, the nesting times themselves might be influenced by tide cycles and weather conditions.

C.2.1.7 Speed, Altitude and Distance off Shoreline

These survey flight characteristics are interconnected. The general guidelines are:

a. For routine beach surveys, fly at 80 knots (75 to 85 knots, if this is a safe speed for the aircraft) at an altitude of 300 feet (200 to 400 feet, lower where beach is suitable for an emergency landing), and at a distance offshore that forms about a 45 degree angle to the water line (about 300 feet offshore).

b. For beaches with dense sea turtle crawls (or with gusty winds), fly at 400 feet altitude, and make 360° turns to resurvey the area, time permitting, if first observations are uncertain.

c. For shorelines without beaches or where turtle crawls are very rare, fly faster (about 130 knots) and at about 400 feet altitude.

d. When flying over water for a few miles or more during a shoreline survey, fly at 500 feet altitude and 110 knots and record any turtles seen (as in *Pelagic Aerial Survey*, C.2.3).

C.2.1.8 Maps and Charts

No optimum and comprehensive set of charts exists for the shorelines of the entire western Atlantic area. For surveying areas new to the survey team, the advice is to get the best charts available before the survey period begins. Generally, two scales of a chart series are useful — a large-scale chart to determine landmarks which separate zones and to measure shoreline distance; a small-scale chart for plotting position in the aircraft during the survey.

Topographic charts are very useful. Those from the U.S. Army Topographic Command (Washington, D.C. 20315) are published for many areas; the useful scales are 1:500,000 and 1:250,000. Charts from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, are available for most areas; a scale of about 1:500,000 may be useful for in-flight recording, but larger-scale charts should be used for selecting landmarks. World Aeronautical Charts (from above source) may be used. Road maps, issued by some oil companies, have been successfully used in some surveys.

The primary map used should be announced with appropriate and useful landmarks (towns, roads, bridges, and other features).

C.2.1.9 Aerial Survey Zones

Before starting an aerial survey, each country, state or other geographical region should be divided into standarized zones, numbered serially beginning with 001. These zones may be from one to forty km long, depending on the density of known nesting or on the uniformity or variabily of the coast. The zones' borders should be based on permanent landmarks (defined above). All landmarks not shown on the primary, large-scale map should be described in relation to points which appear on this map. The *Aerial Survey Zones* should be the same for *Ground Survey*, except that the latter may be sub-divided into smaller units that can be patrolled in a reasonable time on foot or by vehicle.

C.2.1.10 Data Recording Form: SEA TURTLE AERIAL SURVEY – COUNTRY/STATE ZONE RECORDS

Form 1 is designed to facilitate: 1) computer entry of data without excessive transcription; 2) comparisons of data from different survey areas, periods, and recorders; 3) a comprehensive compatible comparison of shorelines (and sea turtle nesting activity) throughout the western Atlantic area.

Form 1. Sea Turtle Aerial Survey. Zone Records.

SEA TURTLE AERIAL SURVEY

Zone Record page _____ of _____

Country/State ZONE RECORDS

COUNTRY_____ STATE _____ Heading(s) _____

Chart(s) Used _____

Recorder(s) _____ Date(s) _____

ZONE LANDMARKS	Start End	Zone No.	Dist-ance KM-NM	Lat.	Long.	Head -ing	SHORELINE CHARACTERS

Form 1 Explanation

a. *Country and State.* Write these in. They will be computer-coded in subsequent analysis of the entire area.

b. *Heading(s).* Give from start to end in approximate degrees or positions. In circling an island, headings will be inclusive.

c. *Chart(s) used.* Give source, number, scale.

d. *Recorder(s).* List names of Survey Leader and/or Research Co-ordinator.

e. *Date(s).* Of form preparation.

f. *Zones.* Each row represents one zone, unless a second or third row are needed and duplicated in the first column.

g. *Zone Landmarks - Start.* The name or title of the Zone is written at the *start* of the zone. When zones are continuous, the end of its preceding zone will be the start of the following zone and will be written in the subsequent row. When zones are discontinuous, the landmark is written in the next row, and the *Zone Number* is duplicated in that row. This can occur when making a shoreline survey along an area and deviating to circle a nearby offshore island.

h. *Zone No.* This is the consecutive number, starting with 001, for each country or state or other area.

i. *Distance KM-NM.* This is the shoreline distance of the zone (measured, calculated, or estimated). The distance can be readily calculated by using a rotating map measurer on a large-scale chart. The recording unit used, Kilometer (KM) or Nautical Mile (NM) is circled.

j. *Lat. Long.* The latitude and longitude in degrees and minutes (to the nearest tenth minute) are calculated from a chart and recorded for the *start* of the zone.

k. *Heading.* Given in degrees or direction for each zone.

l. *Shoreline Characteristics:* This is a synopsis of the characteristics of the shoreline that occur in each zone. See the section C.2.1.11 for descriptions. Where more than one type of shoreline occurs along a zone, either record the dominant type or give the different types in estimated percentages. However, the primary purpose of this survey is to document active or potential sea turtle nesting beaches, *and* the presence and relative amount of any high-energy or low-energy sand beaches should always be recorded in each zone.

C.2.1.11 Shoreline Characteristics

These categories will be used in initial aerial surveys (and reconfirmed on subsequent flights) to record the nature of the shoreline. Determining which areas are most likely to be sea turtle nesting sites allows for more efficient planning for subsequent aerial surveys. (More detailed study and recording of these features should be part of *Ground Surveys).*

a. *Sand Beach: High-Energy.* Beach open to heavy surf with significant portion above high tide; profile is moderately steep.

b. *Sand Beach:Low-Energy.* Beach with gentle profile, no dunes; breaking surf far from shore, often with several bars seaward of the beach.

c. *Sand Beach: General Comments.* In addition to classifying sand beaches as high or low energy, they should be sub-classified as either: Sand only. Sand and shell. Sand and rocks. Sand and vegetation. Sand and driftwood.

d. *Pocket Beach:* Typically a small arcuate sand beach between cliff pomontories.

e. *Rocks:* Rocks or reefs obstruct beach approach. Surf breaks on rocks.

f. *Cliffs:* Cliffs form shoreline. Surf breaks on cliffs.

g. *Vegetation:* Describe extent of vegetation to high-tide line. Note types as: Vines. Grasses. Mangroves. Coconut trees. Indeterminate.

h. *Coastal Lagoons, Swamps or Marshes:* Record: Narrow channels. Wide lagoons. Estuaries. Mangrove swamps. Herbaceous marshes.

i. *Human Development* (on or near shore): Record: Houses. Hotels. Miscellaneous buildings. Sea walls or shore protection constructions. Roads. Paths. Docks. Anchorages. Dredging. Channels. Large/small vessels. Fish traps.

j. *Human use:* Record: High, or low, or no apparent human use. Bathing. Fishing. Sand Removal. Beach cleaning.

k. *Animal use:* Cattle. Pigs. Goats. Horses. Wild animals. Birds. Crabs.

l. *Nearshore:* Bare sediments. Vegetated bottom. Rocks. Barrier reefs. Patch reefs.

C.2.1.12 Data Recording Form: SEA TURTLE AERIAL SURVEY – FLIGHT DATA RECORDS

This recording form (see Form 2) and descriptions it requires can be used for, or in combination with *Pelagic Aerial Surveys* or other more detailed surveys.

The goal is to record the *total number of sea turtle crawls* evident within each zone, and any other signs of turtles or their activity observed in each zone. Other data, including species identification, are important and should be recorded in Form 2 when possible, especially when making multiple surveys of an area.

Form 2. Sea Turtle Aerial Survey. Flight Data Records.

SEA TURTLE AERIAL SURVEY

Flight page___ of _____

FLIGHT DATA RECORDS

OBSERVER 1 _____

OBSERVER 2 _____

RECORDER _____

PILOT _____

AIRCRAFT _____

Ground truth survey made_____

Zone Record form on file _____

COUNTRY_____ STATE _____

ZONES _____

DATE _____ TIME:S _____ E_____

Weather: Current _____ 24hrs. _____

Temperature: Beach Air _____ Surf _____

Sea State _____ Visibility_____

ZONE Description	ZONE No.	TIME	CRAWLS				SPEC-IES	TURT-LES	FLIGHT DATA	SHORELINE DATA (& other)
			Fresh		OLD	TOTAL				
			Nest	False						

Form 2 Explanation

a. *Ground Truth Survey Made.* Check or write YES, if a *Ground Truth Survey* was made on the day of, or the night before, or within one or two days prior to the survey. Note the *Zone Numbers.*

b. *Zone Record Form on File.* Check or write YES, if a *Zone Record Form* has been prepared. If not, prepare one.

c. *Country and State.* Enter name(s). Code numbers will be assigned later.

d. *Date.* Year, month, day. Example: Write 2 May 1981 as 810502.

e. *Time.* Use 24-hour clock, noting times of takeoff (S) and landing (E).

f. *Weather.* Give weather description for both the time survey starts (over first zone) and for previous 24 hours, if known. If the weather changes during the survey, note this at appropriate time(s) in the Flight Data Column. Use the following code:

0 = clear or few clouds
1 = partly cloudy or scattered clouds or variable sky
2 = cloudy (broken or overcast)
3 = fog, haze or smoke
4 = drizzle
5 = rain
6 = rain with hail
7 = showers
8 = thunderstorms

g. *Sea State.* Use the Beaufort Scale code numbers, as follows:

Codes Wind Force (Beaufort)	Miles per Hour	Knots	Descriptive	Probable Wave Height (in Feet)
00	0-1	0-1	Calm	—
01	1-3	1-3	Light Air	1/4
02	4-7	4-6	Light Breeze	1/2
03	8-12	7-10	Gentle Breeze	2
04	13-18	11-16	Moderate Breeze	4
05	19-24	17-21	Fresh Breeze	6

h. *Visibility.* Depending on ability to see the beach and see turtle crawls, record as: Excellent. Good. Fair. Poor.

i. *Air Temperature.* If possible, record or get temperature records near or during survey time. Record to the nearest tenth degree centigrade.

j. *Personnel.* Give last names and all initials of all personnel and record seat each occupied (as in right-front: RF).

k. *Aircraft.* Name and model.

l. *Zone Description.* Enter either name of starting landmark, *or* name of the zone (if so designated). This is not necessary if a Zone Record is on file and recorders and observers know the survey track.

m. *Zone Number.* As described above.

n. *Times:* Use the 24-hour clock, to the nearest minute; identify local time to GMT. Generally, record only the time the zone is started, unless there is a specific reason to record events within a zone. In that case, list the Zone Number again in the next row. In the case of Zones that are not contiguous, use the next row to record start *and* end time, for specifically identified zones.

o. *Crawls: Fresh — Nest.* Record the number of completed crawls (those that resulted in an obvious or apparent nest) *and* that were obviously or apparently made within 24 hours of the flight.

p. *Crawls: Fresh — False.* Record the number of false crawls which were made during the previous 24 hours but which *did not result in a nest.*

q. *Crawls: Old.* Enter the number of crawls (both nest and false) that apparently were made during the previous two or more days.

r. *Crawls: Total.* Enter the *total number of crawls* counted. Record this total number, even if some crawls are recorded in one or more of the three categories described above. Note: If crawl counts made by two or more observers differ, record each observer count on a separate row duplicating the Zone Number for later assessment of observation efficiency and difficulty.

s. *Species.* Record as certain or unknown species. If identification is uncertain, indicate with (?). Use the following code.

CC = *Caretta caretta*	loggerhead
CA = *Chelonia agassizi*	black
CD = *Chelonia depressa*	flatback
CM = *Chelonia mydas*	green
DC = *Dermochelys coriacea*	leatherback
EI = *Eretmochelys imbricata*	hawksbill
LK = *Lepidochelys kempi*	Kemp's ridley
LO = *Lepidochelys olivacea*	olive ridley
UK = Unknown	

t. *Turtles.* Record number of any observed turtles or turtle remains (carcasses, shells, bones on beach), daytime nesting, or crawling, or swimming or basking in the water). Describe the observed events in the *Shoreline Data Column.*

u. *Flight Data.* Record any changes in flight characteristics or weather that occur during the survey.

v. *Shoreline Data (and other).* See section C.2.1.11 for description of shoreline characteristics. Make any other notes of value here. Also record tide during flight, writing "tide" and using the following code:

1 = going out/ebbing
2 = coming in/flooding
3 = slack high/high water slack/high tide
4 = slack low/low water slack/low tide

As soon as possible after the survey flight, hold a debriefing session with all flight personnel and thoroughly check all record forms. Rewrite and make copies of forms as appropriate.

C.2.2 Ground Truth Beach Surveys for Beach Aerial Surveys.

Ground Truth Beach Surveys are needed primarily during nesting seasons along beaches that have significant nesting activity. These surveys normally provide more precise and detailed accounts of sea turtle activity than *Beach Aerial Surveys.* Results of *Ground Truth Beach Surveys* for a limited beach area can aid in interpreting results of *Beach Aerial Surveys* of much greater shoreline distances. They are highly recommended.

C.2.2.1 Location.

Whenever possible, a *Ground Truth Beach Survey* should cover one entire Zone of the *Beach Aerial Survey.* If the *Ground Truth Beach Survey* covers only part of a Zone, that portion should be marked *before* the airplane passes by so that the aerial observers can identify that section separately on their record form.

C.2.2.2 Time.

Ideally, the *Ground Truth Beach Survey* should be made early in the morning on the same day as the *Beach Aerial Survey,* with two exceptions:

1) When ground surveyors are already making routine or special night time visits to a nesting beach to record and tag females.

2) Where sea turtles (e.g. Kemp's ridley) nest during the day.

Ground Truth Beach Surveys made of beaches at other times and dates can be useful, however, and their results should be incorporated into *Beach Aerial Surveys.*

C.2.2.3 Data Recording Form: SEA TURTLE GROUND TRUTH BEACH SURVEY.

This form is intended specifically for use with *Sea Turtle Beach Aerial Surveys.* It also can be used independently to provide daily records of crawling and nesting (Form 3).

Form 3. Sea Turtle Ground Truth Beach Survey.

SEA TURTLE GROUND TRUTH BEACH SURVEY

Aerial Survey Made _____
Zone Record Form on File _____

COUNTRY _____ SURVEY LEADER _____

STATE _____ ZONE: Name _____ No. _____

START Survey: Date _____ Time _____ Shore Length of Zone _____ KM
END Survey: Date _____ Time _____ PORTION OF ZONE _____

WEATHER: Current _____ 24 hrs _____ Length of Portion _____ KM
TEMPERATURE : Beach, Air _____ Surf _____ Name of Beach _____

Other signs of Sea Turtle Activity _____

Human Activity _____

SPECIES	NUMBER OF CRAWLS								
	FRESH			OLD			TOTAL		
	Nest	False	Unknown	Nest	False	Unknown	Nest	False	Unknown
TOTAL									

CC = *Caretta caretta* EI = *Eretmochelys imbricata*
CD = *Chelonia depressa* LK = *Lepidochelys kempi*
CM = *Chelonia mydas* LO = *Lepidochelys olivacea*
DC = *Dermochelys coriacea* UK = *Unknown species*

Form 3 Explanation

a. Details on the upper part of the form are explained in C.2.1.12 *(Flight Data Records).*

b. *Species.* Record the one or more species identified or list as unknown.

c. *Number of Crawls.* Record in Fresh Crawl *or* Old Crawl columns only when the identification is certain; if uncertain, record in the appropriate column. Note that if there are one or more uncertain Fresh or Old Crawls, the numbers in the Total column will exceed the sums of the Fresh and Old Crawl columns.

C.2.3 Pelagic Surveys.

These surveys are made over water, usually following a previously designed flight pattern. Their purpose is to count sea turtles on the sea's surface. In clear and/or shallow reef areas, sea turtles beneath the surface are also counted.

Some of these surveys have multiple purposes, for instance, locating and counting sea turtles, as well as marine mammals, sea birds, fishes, and fishing and other vessel activities.

This first edition of the Manual lists general aspects of *Pelagic Surveys* and gives some suggested guidelines.

a. *Aircraft.* Most pilots and researchers experienced in offshore surveying recommend a two-engine aircraft. A high-wing model is best because it offers optimum visibility. However, for relatively short over-water flights, or for survey patterns from one-half to 5 miles offshore, good results can be obtained with less costly single-engine, high-wing aircraft suggested for *Beach Aerial Surveys.* All reasonable precautions are urged.

b. *Personnel.* A minimum of four is recommended with at least one observer seated on each side of the air craft.

c. *Speed and Altitude.* With good visibility and calm seas speeds of 90 to 130 knots are satisfactory. About 110 knots is ideal. Elevation of 500 feet is probably best, with an acceptable range of 300 to 700 feet.

d. *Records.* A planned flight pattern usually consists of continuous offshore, alongshore, and inshore segments or legs. Record the starting and ending time of each segment and the times of sea turtle sightings and other related events along each segment. The events' relative positions will be adjusted by time fractioning later.

e. *Data Forms.* Form 2 provided above for *Beach Aerial Survey* can be used also for *Pelagic Surveys.*

C.2.4 Other Aerial Observations

Sea Turtle Aerial Surveys (Form 2) should also record information on the numbers, kinds and locations of vessels that may affect turtles. Such vessels include canoes and small power launches which systematically capture turtles for local consumption or commercial purposes and also larger fishing trawlers which may incidentally capture turtles. Surveyors should be able to observe captured sea turtles, except very small ones, in open boats.

Characteristic postures of turtle fishermen about to harpoon or jump on a turtle resting on the surface can soon be recognized.

All marine mammals sighted during the *Sea Turtle Aerial Surveys* should be recorded. Include species or genus identification (if known) or description, number, estimated size(s), and location. Concentrations of fishes or sea birds also should be recorded.

Photography can be useful to record dense crawls on a beach for later counting or for species identification. Recommended features are: Shutter speed 1/1000 sec.; f-stop one greater than metre reading; color film 100-200 ASA; black and white film 32-64 ASA; expose perpendicular to the shoreline.

C.3 Vessel Surveys

Most sea turtle field research has been related to females and hatchlings on nesting beaches. Since relatively little is known about the rest of the sea turtle life history, vessel surveys hold great promise for future research. Like aerial surveys and remote sensing techniques, however, vessel survey methods — what gear to use; how to capture and observe turtles — are still being developed.

Where sea turtles are relatively abundant, and where there are few bottom obstructions (as in Cape Canaveral Ship Channel on the east-central coast of Florida), trawling for 15 to 30 minutes with shrimp trawls or large-mesh trawls on the bottom is an effective method for live capture of sea turtles of both sexes and various sizes for tagging and other studies. Trawling is also useful for catching sea turtles on which to mount radio and sonic tracking transmitters for later monitoring.

The researchers can use three types of *Vessel Surveys.* In order of preference, they are:

a. Dedicated vessel. Preferred but most expensive method.
b. Dedicated observer aboard a co-operating commercial fishing vessel.
c. Ships of opportunity.

On a vessel dedicated either by contract or by outright ownership, the researcher can design a survey with minimal experimental bias.

This Manual does not attempt to instruct on proper statistical sampling design; however, the survey should strive for random spatial and temporal sampling, standarized sampling techniques (trawl size, down time, etc), quantified catch per unit of effort (CPUE), and include all helpful data such as weather, sea state, glare, etc.

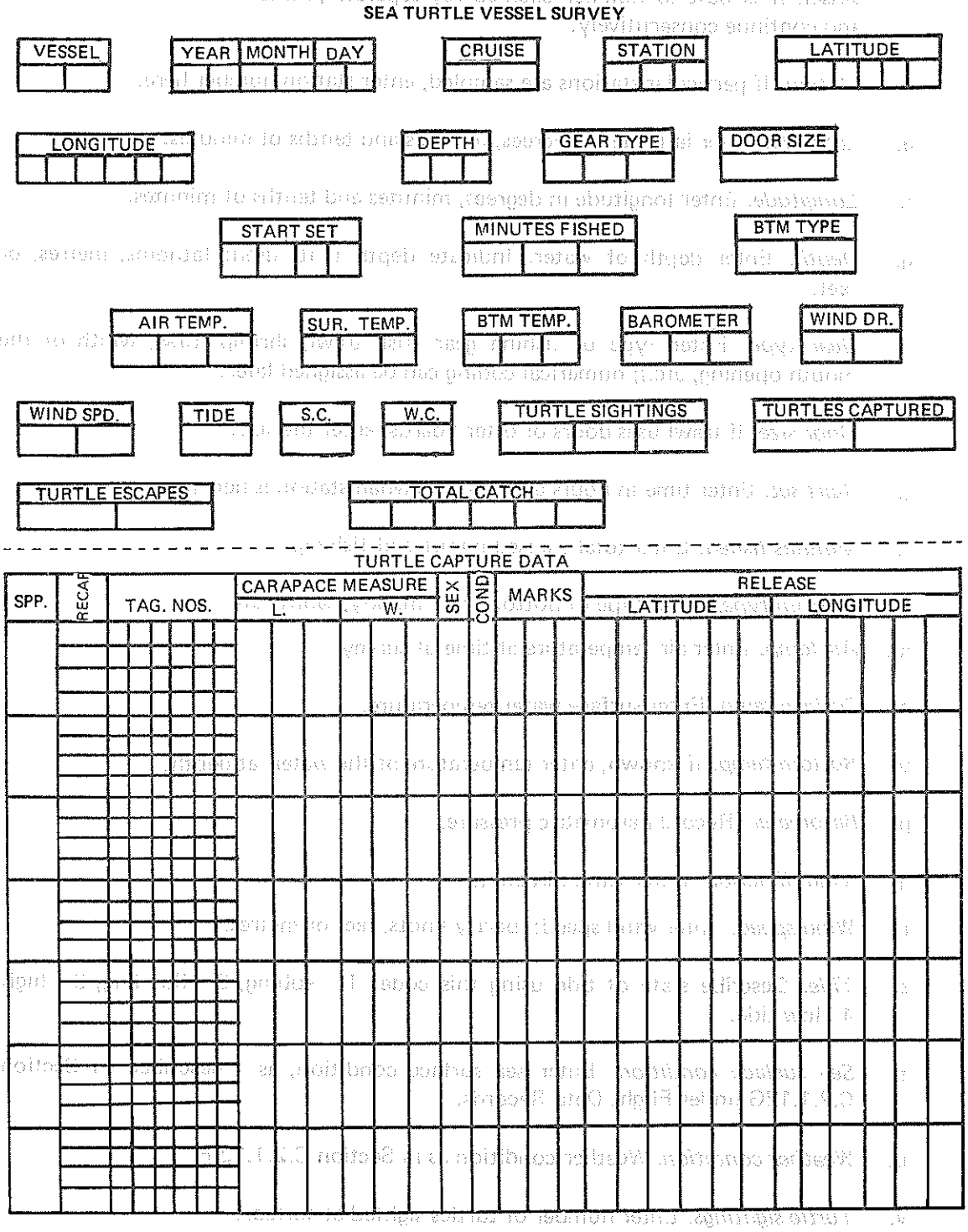
The sampling programme of a dedicated observer aboard a commercial fishing vessel will obviously be limited by where and how the boat's captain chooses to fish. Hence spatial and temporal biases will almost certainly enter into the survey. Reduced programme costs often outweigh these limitations, and most of the important data can still be acquired and the results can be statistically valid.

Ships of opportunity (vessels of any type without dedicated or trained observers aboard) can provide some useful data but neither the level of effort nor much of the resulting data can be quantified. Although this type of survey can provide some insights into seasonal distribution, caution should be used in interpreting the data.

C.3.1 Data Recording Forms: VESSEL SURVEY RECORDS

The primary purpose of Form 4 is to record the number of turtles caught in a dedicated vessel survey; it can be adapted for use by observers on commercial fishing vessels.

Form 4. Sea Turtle Vessel Survey.



Form 4 Explanation

a. *Vessel.* Enter name. Code numbers will be assigned later.

b. *Date.* Enter year, month, day, example: Write 2 May 1981 as 810502.

c. *Cruise.* Since more than one survey cruise may be conducted aboard a particular vessel, it is best to number each survey separately. Enter 01 for the first cruise and continue consecutively.

d. *Station.* If particular stations are sampled, enter station number here.

e. *Latitude.* Enter latitude in degrees, minutes and tenths of minutes.

f. *Longitude.* Enter longitude in degrees, minutes and tenths of minutes.

g. *Depth.* Enter depth of water. Indicate depth units used: fathoms, metres, or feet.

h. *Gear type.* Enter type of fishing gear (fish trawl, shrimp trawl, width of the mouth opening, etc.); numerical coding can be assigned later.

i. *Door size.* If trawl uses doors or otter boards, enter the size.

j. *Start set.* Enter time in hours and minutes when station is begun.

k. *Minutes fished.* Enter total elapsed minutes of fishing.

l. *Bottom type.* Enter type of bottom, i.e., muddy, sandy, etc.

m. *Air temp.* Enter air temperature at time of survey.

n. *Surface temp.* Enter surface water temperature.

o. *Bottom temp.* If known, enter temperature of the water at depth.

p. *Barometer.* Record barometric pressure.

q. *Wind direction.* Enter wind direction.

r. *Wind speed.* Enter wind speed; specify knots, feet or metres.

s. *Tide.* Describe state of tide using this code: 1 ebbing; 2 flooding; 3 high; 4 low tide.

t. *Sea surface condition.* Enter sea surface condition, as described in Section C.2.1.12G under Flight Data Records.

u. *Weather condition.* Weather condition as in Section C.2.1.12 F.

v. *Turtle sightings.* Enter number of turtles sighted at surface.

w. *Turtles captured.* Enter number of turtles caught in trawl.

x. *Turtle escaped.* Enter number of turtles that escaped while net was being brought aboard.

y. *Total catch.* Enter weight of total trawl catch, minus any turtles.

On the bottom of the form, record additional data on each turtle caught during the sampling. Include:

a. *Spp.* Species:

CC = *Caretta caretta*	loggerhead
CA = *Chelonia agassizi*	black
CD = *Chelonia depressa*	flatback
CM = *Chelonia mydas*	green
DC = *Dermochelys coriacea*	leatherback
EI = *Eretmochelys imbricata*	hawksbill
LK = *Lepidochelys kempi*	Kemp's ridley
LO = *Lepidochelys olivacea*	olive ridley

b. *Recap.* Was this turtle a recapture? *Yes* or *No.*

c. *Tag numbers.* If the turtle was recaptured, record old tag number(s) and, if new or retagged, enter new tag number(s).

d. *Carapace measure.* Enter both carapace length and width. Specify units used.

e. *Sex.* Indicated as follows:
M = Male
F = Female
U = Unknown

f. *Condition.* Code turtle condition as follows:
1 = active, little or no growth on shell
2 = active, heavy growth (barnacles, etc.) on shell.
3 = inactive, sluggish
4 = comatose or torpid
5 = dead

g. *Marks.* Record any wounds, mutilations or distingushing characteristics.

h. *Release.* Enter the latitude and longitude of the release site, using format above (e and f).

C.4 Ground Surveys.

C.4.1 Nesting Beach Surveys

One or more survey team members will patrol selected beaches, usually for two to eight hours after sunset, to record sea turtle activities and to measure and tag emerging females when possible. Apparently, in many areas, particularly when low tide exposes rocks or flats, turtles come ashore on the rising tide as it approaches high tide, and return to the sea on the falling tide. However, patrols lasting the entire night are necessary to confirm this trend on a particular beach before briefer patrols can de designed to coincide with peak nesting hours.

Nesting beaches can be surveyed during the daytime; in Mexico, Kemp's ridley invariably nests by day. Hawksbills in the Seychelles and flatback turtles in northern Australia also often nest day, as do olive ridleys during major arribadas. Daytime *Ground Truth Surveys* are also necessary to confirm aerial survey data. Sampling efforts and units should be clearly defined prior to and used consistently throughout a survey; this allows for comparison with other units in the country or region and with published information. Generally, ground survey zones should correspond to aerial survey zones. However, if an aerial survey zone is relatively long (such as 32 km), the beach survey zone might be divided into smaller units (such as 10 sub-zones of 3.2 km each).

The following data should be recorded on beach surveys:

a. *Sampling effort:* Dates and hours of patrol; length of beach covered (miles or kilometers); number of turtles observed and number of tracks made by turtles not observed; weather conditions; air and water temperatures.

b. *Turtle Activity.* Include.

1. Species identifications (from the turtle, its tracks and nest characteristics, or subsequent identification of hatchlings).

2. Number of turtles in each defined beach unit.

3. Number of nests. Include number of eggs laid in each nest only when this can be determined without handling the eggs excessively. For example, gather such data when running a hatchery; it is wise to count only a small sample of nests.

4. Number of false crawls or false nesting attempts before successful laying, where this can be determined. For example, a single track may indicate several attempts to nest before nesting is successful; or an individual turtle may be seen on the beach and identified by her tag numbers for several successive nights before she finally nests successfully.

5. Turtle measurements (see Section C.4.2).

6. Presence of any prior tags (on flippers or shells) or evidence of the turtle having previously been tagged. Report serial number, kind, location, and return address of tags from other tagging projects. Do not remove old tags unless they are badly corroded or about to fall off (see Section C.4.3.7). If you remove an old tag, replace with a new tag.

7. Data on new tags placed on turtles during the survey, including serial number. Placement of tags and return address presumably will be same for all tags used, but should be stated (see Section C.4.3).

c. *Turtle Activity Records from Previous Nights.*

1. Number of old crawls, identified where possible as nesting crawls and false crawls.

2. Number of nests, identified when possible as: still incubating, hatched or disturbed.

3. Number of turtle carcasses. State cause of death if it can be determined.

4. Species identification.

d. *Hatching Success.* This should be based on either:

1. Subsequent observations (see Section C.4.5).

2. Egg removal to a hatchery, including description of transplant technique.

e. *Human Activity.* Examples include: egg harvesting, turtle capture, fishing, cattle herding, recreational activities, etc.

C.4.2 How to Measure Sea Turtles.

Procedures for measuring sea turtles are similar for all species, but measuring techniques may vary depending on size of the turtle and availability of equipment. A variety of measurements have been taken in the past. This section recommends specific measurements, describes alternatives, and emphasizes that all measurements be precisely recorded.

C.4.2.1 **Straight and curved measurements.**

A *straight-line* measure of carapace length and width is recommended (see Figure 13).

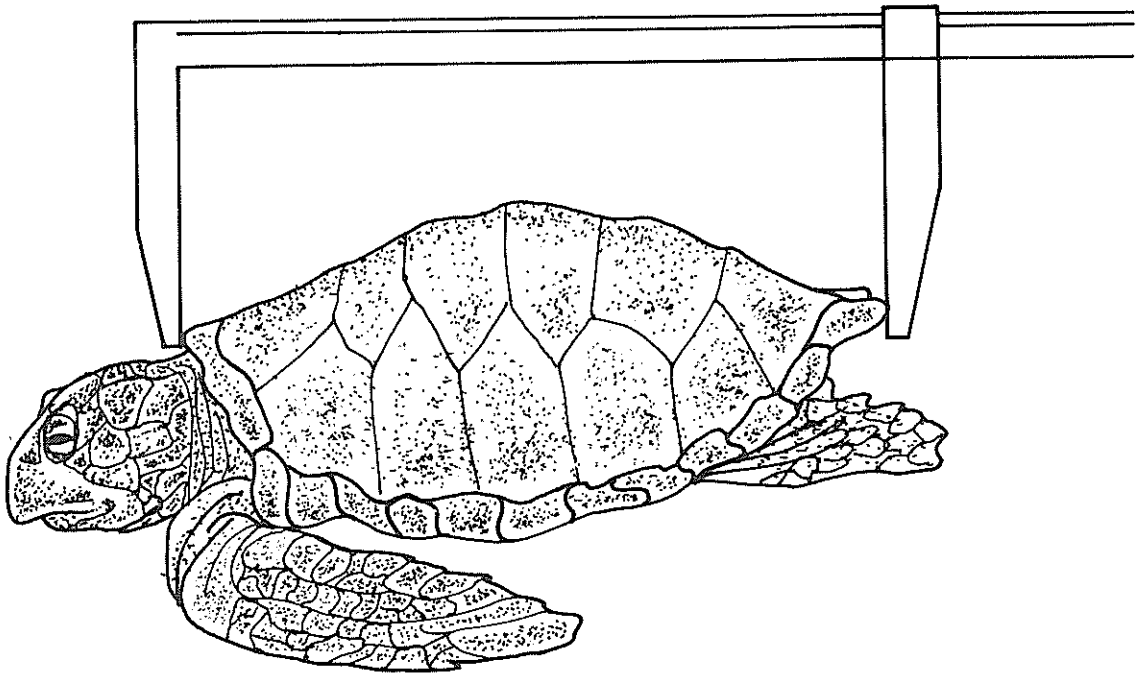


Figure 13. Measuring the carapace length: ***straight-line method*** using calipers (recommended).

A sliding or hinged caliper is usually used, although a tape measure or ruler held parallel to and carefully aligned with the shell is an acceptable alternative. Another common but less preferable technique is a *curved measurement* in which a flexible metal or cloth tape is placed along the shell's contour (see Figure 14).

Recording *both* straight and curved lengths and widths gives a potential index to body thickness. All measurement records must specify which method was used. Both are described in more detail below.

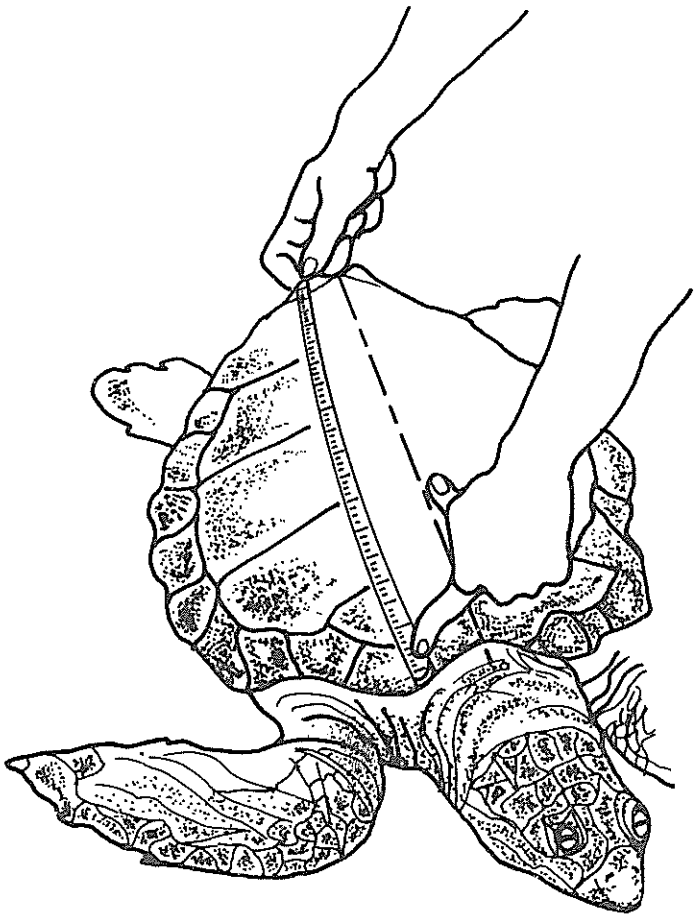


Figure 14. Measuring the carapace length: ***curve-line method,*** using flexible tape.

C.4.2.2 Standard measurements

Four standard sea turtle measurements are defined in this Manual: a) Carapace length; b) Carapace width; c) Tail measurements; d) Weight.

Other measurements, such as head and plastron length and width, are not needed for applied research with which this Manual is concerned.

For nesting beach surveys in which only carapace length and width are being recorded, a female should not be turned on her back without a specific reason.

C.4.2.3 Carapace length.

At least four different pairs of points have been used for measuring carapace length (Figure 15). *Standard carapace length is recommended* (see Figure 15, A). Any recorded measurements should specify which method was used.

Fig. 15, A. *Standard carapace length* (SCL) – precentral scute to posterior margin of postcentrals.

Fig, 15, B. *Total carapace length* (TCL) – shoulder to posterior margin of postcentrals.

Fig. 15, C. *Notched carapace length* (NCL) – shoulder to notch between postcentrals.

Fig. 15, D. *Minimum carapace length* (MCL) – precentral scute to notch.

The recommended method of measuring carapace length is straight-line standard carapace length (Figures 13 and 15, A). This measurement is more precisely defined as follows: the maximum straight-line distance along the midline from the anterior margin of the precentral scute to the posterior edge of the postcentral scute.

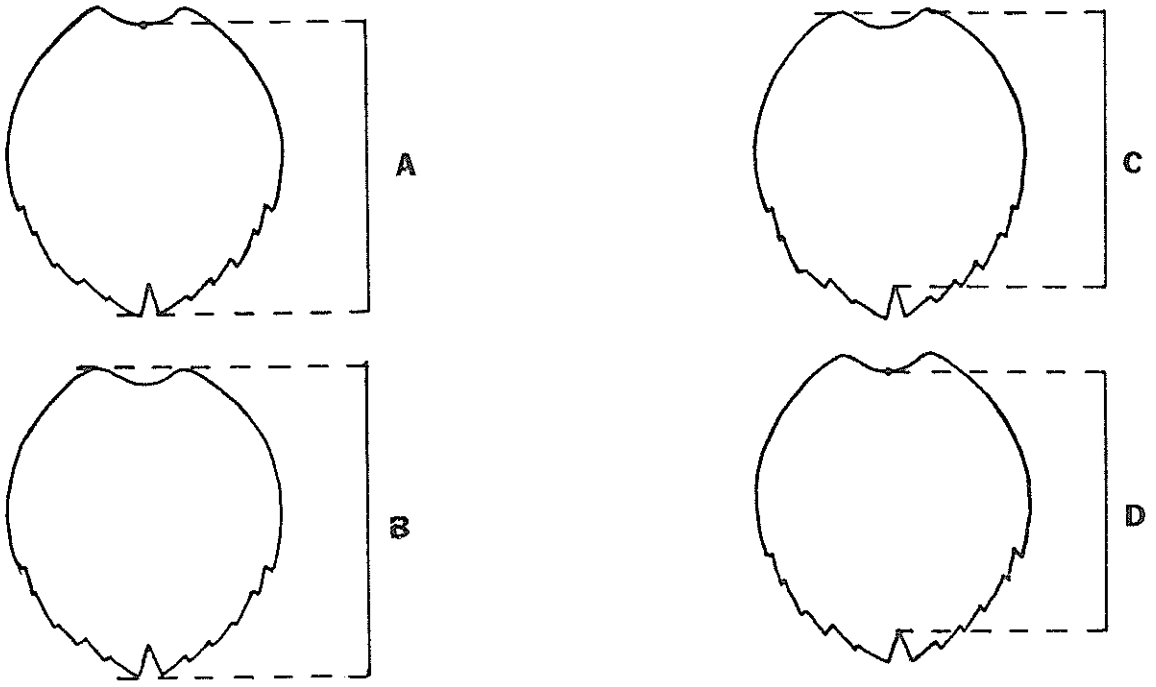


Figure 15. Four sets of anatomical points for measuring carapace length; A is preferred (see C.4.2.3).

C.4.2.4 Carapace width.

Carapace width is the distance across the widest part of the shell, perpendicular to the longitudinal body axis. *Straightline carapace width measurements are recommended* (see Figure 16). If a *curved measurements* is obtained using a flexible tape, it should be clearly specified.

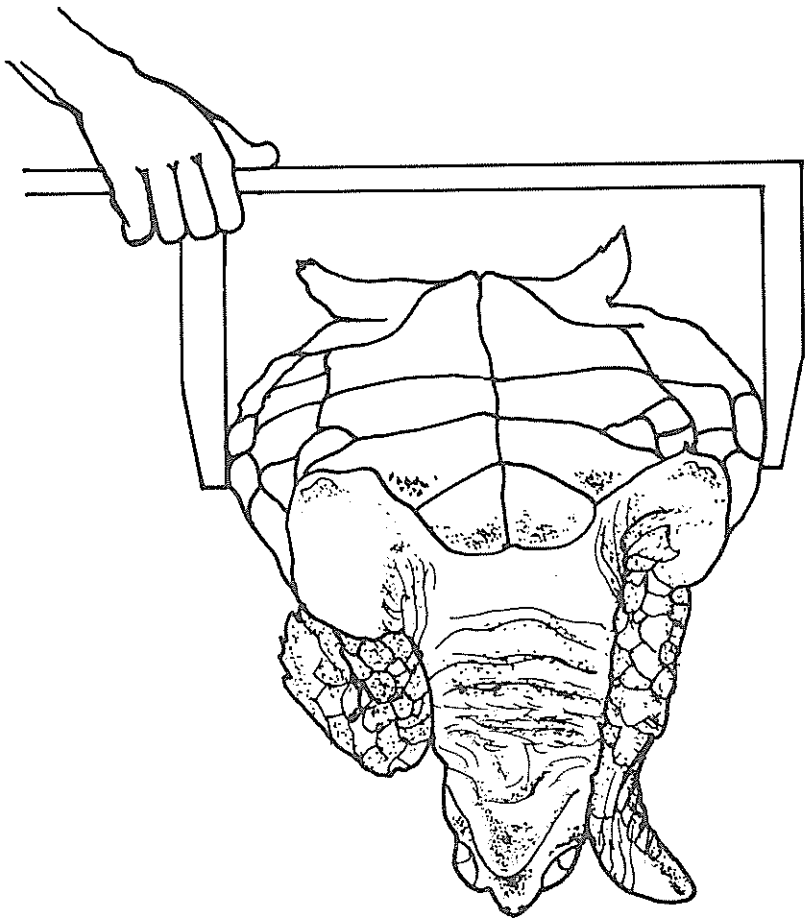
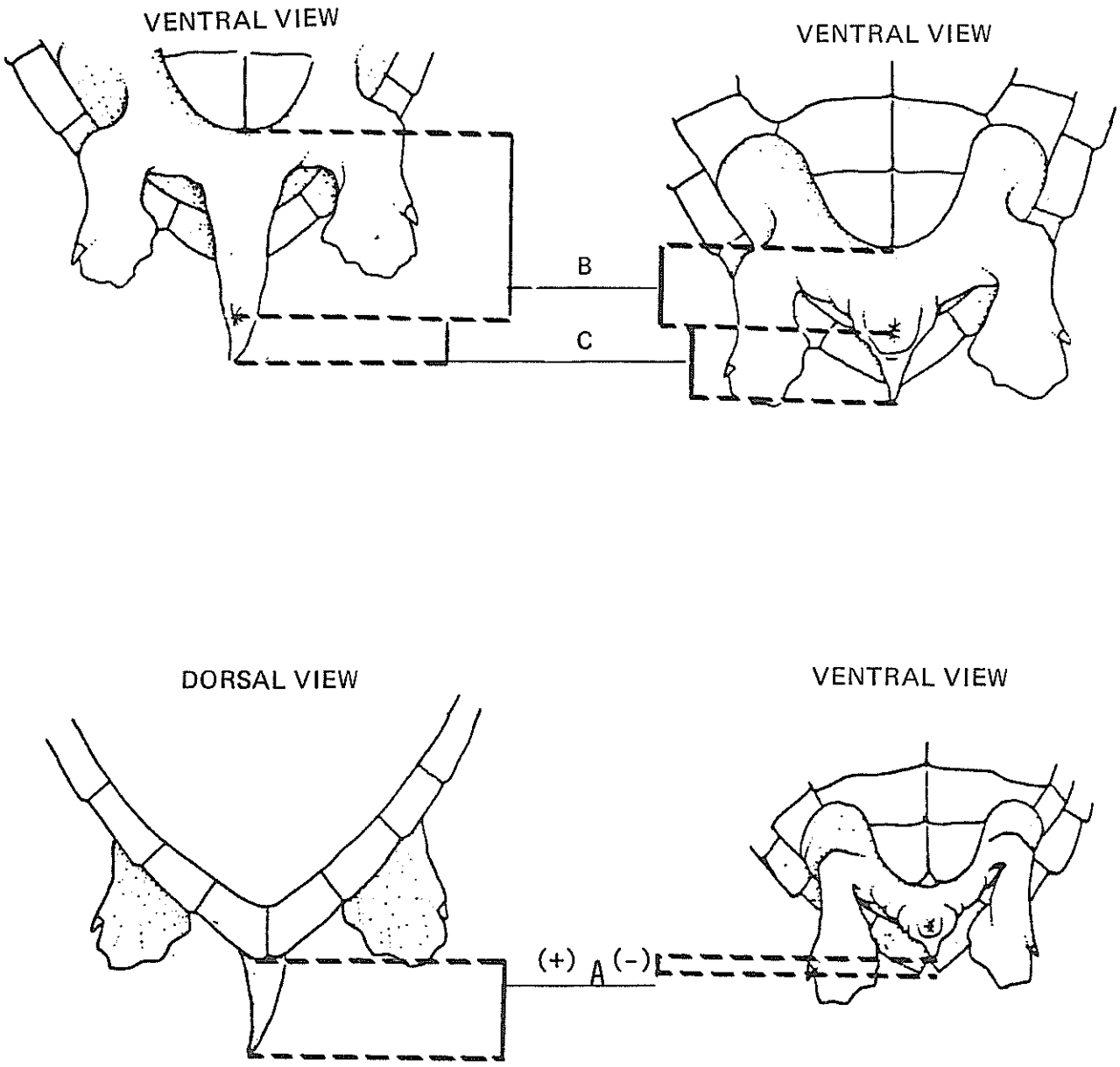


Figure 16. Measuring the carapace width: straight-line method using calipers (recommended).

C.4.2.5 Tail measurements.

Tail length is the major secondary sex characteristic in mature sea turtles. Large sea turtles of all species with long tails that extend well past the posterior margin of the carapace are males (Figure 17, lower left). Similarly, large turtles having tails which do not extend beyond the carapace are females (Figure 17, lower right). For smaller mature and subadult sea turtles, however, the relationship of tail length to sex is not known.

Along with carapace length and width, and weight (where possible) for size ranges of all species, tail measurements can help determine morphological and sex relationships. The three tail measurements shown in Figure 17 are recommended.



A. Posterior margin of carapace to tip of tail (with a plus sign prefix) or tip of tail to posterior margin of carapace (with a minus sign prefix).
B. Posterior margin of plastron to mid-vent.
C. Mid-vent to tip of tail.

Figure 17. Recommended tail measurements (see C.4.2.4).

C.4.2.6 Weight

The type of scale used will depend upon the weight of the turtle. To weigh a turtle less than about 2600 g (5.7 pounds), use a triple beam balance equipped with a scoop or rimmed pan. Record weights to the nearest 0.1 g although wind effects during field surveys may limit accuracy of the balance to approximately $\pm$ 5 g. To weigh turtles heavier than 2600 g, use spring dial scales having appropriate capacities.

A weighing device is available for shipboard use. Mount a large single beam balance (200 pounds, modified with supplemental weights for up to 500 pounds) to a block and tackle suspended from the ship's rigging. Place the turtle in a circular net (5-feet diameter) with a rope margin. Attach the rope to the beam's lower hook and hoist the turtle and net off the deck for weighing.

Nesting females can be weighed with a spring dial scale mounted to a horizontal pole. Tie or net the turtle to the scale and use the pole supported on the shoulders of two people to lift her off the beach for weighing.

C.4.3 Tagging Sea Turtles

Preferred tag type. Turtles are usually tagged with Monel-metal tags generally used for ear-marking livestock. Several companies manufacture these tags; the authors will supply trade information upon request.

Tags come to sizes suitable for both adult and juvenile turtles. The largest are made from a metal strip 0.9 cm wide and about 8.5 cm long, which gives a folded length of approximately 4 cm. The smallest can be used on turtles about one year old. Tag manufacturers supply special applicators; some resemble a simple plier with the working surfaces molded to fit and enclose a tag, while others have levers arranged to allow the tag to be clinched with less hand pressure. See Figure 18 illustrating commonly used tags.

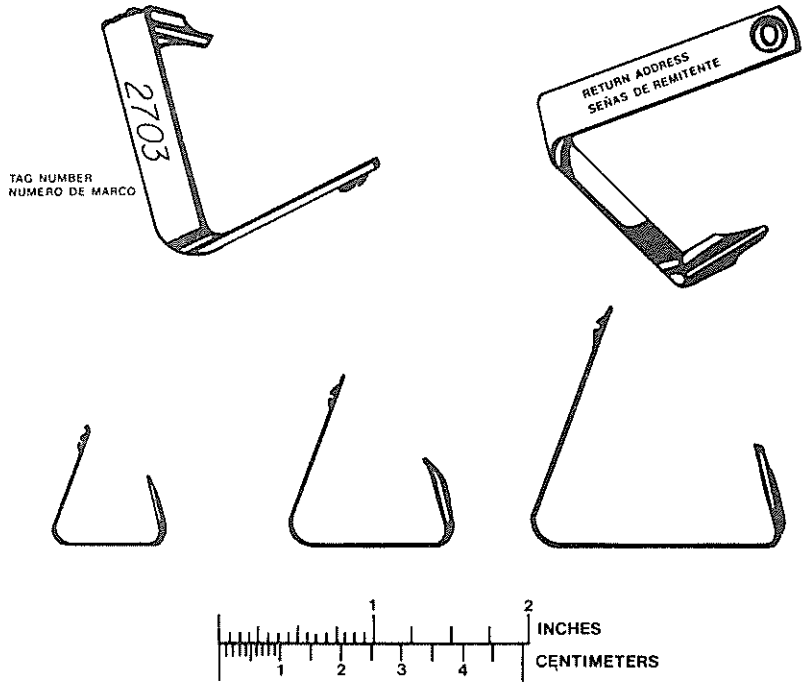


Figure 18. Commonly used turtle tags.

The code numbers and base lengths for the three sizes of tags illustrated in Fig. 18 are: Small, No. 4. 13/16 in. Medium, No. 681, 1-1/8 in. Large, No. 19, 1 11/16 in.

Some workers prefer to perforate the flipper with a pointed chisel before applying the tag. This can prevent the non-clinching that frequently occurs when the turtle's tough skin deflects the tag tip.

2. **Where to tag.** Most workers tag turtles through the trailing edge of one foreflipper, either between or through the large scales edging the center part of the flipper (Figure 19).

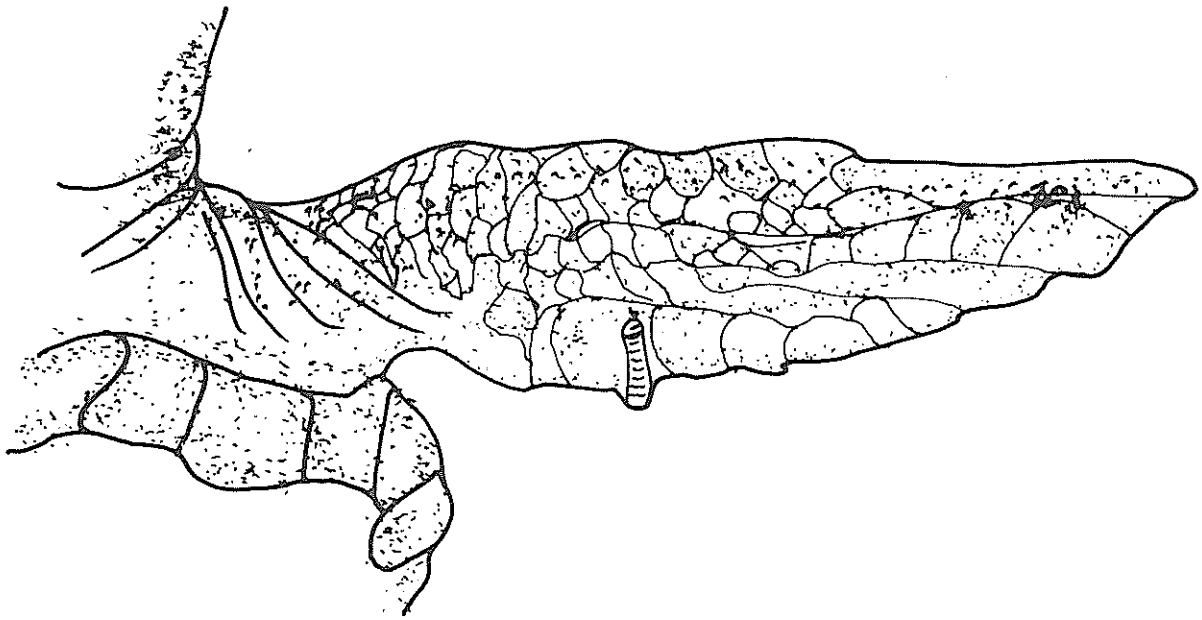


Figure 19. Method of tagging the trailing edge of foreflipper.

Double-tagging is recommended whenever possible if there is an adequate supply of tags. Separate (and usually consecutively numbered) tags are fixed to *each front flipper.* This procedure may partially offset the erratic loss of flipper tags.

3. **When to tag.** Deciding when to tag a turtle depends on the conditions of each survey. If turtles are very numerous and if a large area must be patrolled or manpower is short, turtles may be tagged at any time. Ideally, however, the nesting females should be tagged only *when the nesting process is completed,* i.e., when the female has nested and turned to re-enter the water. Some surveyors have tagged sea turtles successfully during oviposition, but others have found that some populations of sea turtles (especially greens), will stop laying eggs and start covering the nest if tagging is attempted. **This Manual recommends that turtles be tagged as late as possible in the nesting process.**

Some workers routinely turn turtles on their backs for tagging after nesting. This Manual, however, recommends tagging turtles while they are upright, if this is safe and convenient. The upright turtle should be restrained while one person holds the flipper and a second applies the tag.

4. **Alternative tagging methods.** Sometimes, a Monel-metal cattle ear tag applied as described stays on a turtle for more than a decade. However, a significant number of tags are lost quickly -- often within a few weeks. Losses may occur when the tag tears through the flesh of the turtle's flipper, when the tag is clinched improperly, or when either the narrow bar that holds the tag tip corrodes or the entire tag corrodes. Tag corrosion appears principally among turtles that spend much of their time in estuaries or lagoons rather than in the open sea.

Tags made with a more corrosion-resistant alloy, such as "Inconel", are better than Monel-metal. Unfortunately, "Inconel" tags are not yet readily available and manufacturers cannot always be easily persuaded to produce them.

Some workers double-tag turtles and/or apply the tags closer to the tip of the foreflipper so that the clinched tag actually encloses the distal phalanges. This must be done carefully so that the tag does not wobble and interfere with the swimming stroke. If clinched firmly, the tags won't be torn out. Some turtle biologists report they can fix tags more firmly to leatherbacks' hindflippers than to their foreflippers.

The enterprising researcher may design and use tags completely different than those described. Early attempts at carapace tags (discs wired through the rear part of the carapace) were largely unsuccessful because the tags damaged the animal or were dislodged during copulation.. A new type of carapace tag attached by a stainless steel bolt seems more promising. Similarly, some researchers have had success with plastic tags; others have not. "Spaghetti tags" (long, thin, cylindrical pieces of flexible plastic strung through a hole in the flipper and imprinted with a number and address) have been tried but do not appear to be satisfactory. Various other types of experimental tags have been described, and some have been tested.

5. **Tagging hatchlings.** There is a pressing need for a method of marking hatchlings in a way that will remain distinctive when the turtle matures. The formidable obstacles to developing such a tag include the tremendous increase in biomass as the turtle grows from about 30 g to 100 kg or more, and the huge number of hatchlings that must be tagged to ensure reasonable odds of one or more surviving to maturity and being found. The methods proposed include inserting a magnet in the body cavity; causing the turtle to have a permanent immunological response to a certain antigen; excising particular marginal scutes, together with the underlying part of the bony shell, and for the leatherback turtles, clipping off the extreme posterior end of the carapace. A disadvantage of all these methods is that only someone familiar with the project and the tagging method could detect a tagged turtle. Also, the mutilation/excision marks may either heal completely and disappear or heal in a way that mimics a natural injury.

6. **What to record when tagging.** When a turtle is tagged, relevant biological data should be recorded. A tagging log should include the serial number of tag or tags, the date, time and location of tagging, whether or not the turtle nested, tidal and meteorological data, carapace length (ideally in a straight-line, but acceptable with a flexible tape if so stated), and possible other parameters (e.g., carapace width, weight). Tag data should be placed in a permanent depository, such as the files of a museum or government agency. No central turtle tag data clearing house now exists, though establishing one is under discussion.

Tag manufacturers imprint a serial number on one face, with or without one or more letter prefixes. Although not done in the past, surveyors should co-ordinate to avoid using the same numbers, since the different return address may not be noticed. The reverse side bears the tagger's name (usually abbreviated) and a permanent institutional address since tags may be returned many years after application. In some cases, the tag offers a reward to the finder of a tagged turtle. A word of caution: where turtles are protected by law, the recoverer may stand in automatic violation. Rewards should not be offered if likely to embarrass persons unfamiliar with conservation legislation.

Two Beach Survey data sheets presented in Section C.4.4 indicate the types of data that should be recorded. Data collection can be modified to suit the specific conditions of a given beach survey project.

7. **What to do when a tag is recovered.** Many turtle tags are recovered by fishermen who have caught and killed the turtle. Tags are also recovered from turtles that were accidentally caught, and often killed, by shrimp trawlers and other trawlers. In these cases, the tag should be removed, opened up, flattened to fit into an envelope, and mailed to the address on the tag. An accompanying letter should give maximum details about the date, time, place and circumstances of the capture, the carapace length, weight, and the turtle species.

If a tagged turtle is observed nesting, or if a tagged turtle is caught alive and can be released alive, the tag should not be removed without strong reasons. These reasons include: a) A tag that is badly corroded, about to drop off or is nearly illegible and has little further useful life. Sometimes the tag face is so damaged that the researcher should ensure that the number has been read correctly; b) Recapture of a turtle that the recoverer recognizes as an exceedingly unusual or noteworthy record; c) When the recoverer has tags and applicators on hand, an exceptionally old, worn tag or a poorly attached one can be replaced before the turtle is released.

8. **Permits for tagging programmes.** Those interested in starting a sea turtle tagging project should consult with their own natural resources or wildlife agencies and obtain any required permits.

C.4.4 Data Form for Sea Turtle Beach Surveys.

A standard data form for *Sea Turtle Beach Surveys* includes information on measuring, tagging, nesting and hatching. The form accompanying this Manual is designed for use in a tagging programme, but it may be used without tagging.

Form 5. Sea Turtle Tagging and Nesting Data Form – Beach Survey.

SEA TURTLE TAGGING AND NESTING DATA FORM – BEACH SURVEY

SPECIES: _____ (circle) NEST or FALSE CRAWL

INVESTIGATOR: _____ DATE _____ TIME: _____

LOCATION: _____ TIDE: _____

EVIDENCE OF PREVIOUS TAG (Circle) YES – NO

OLD TAG NUMBER 1: _____ OLD TAG NUMBER 2: _____

NEW TAG NUMBER 1: _____ NEW TAG NUMBER 2: _____

SURF WATER CONDITION (circle) CALM, MOD. (2-3 feet) ROUGH (3-6 feet)

CARAPACE LENGTH: _____ cm ☐ inches ☐ Weight: _____ kg ☐ Lbs ☐
straight/curved (circle)

CARAPACE WIDTH: _____ cm ☐ Inches ☐
straight/curved (circle)

COMMENTS: VEGETATION _____

STRUCTURES: _____

OTHER: _____

DISTANCE NEST CONSTRUCTED FROM MEAN HIGH WATER LINE: _____ m ☐ ft. ☐

TOTAL NUMBER OF EGGS: _____

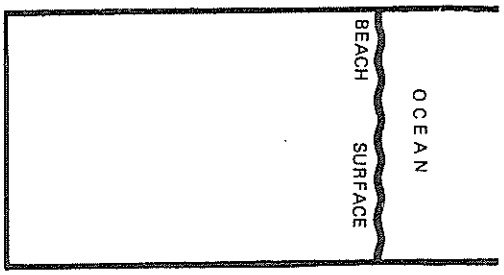
FATE OF NEST: INCUBATION DAYS: _____ NUMBER OF HATCHLINGS: _____

PERCENT HATCH: _____

COMMENTS: _____

TOTAL INVESTIGATING TIME: _____ Hours/ _____ Minutes/

CRAWL DIAGRAM
(Sketch Here) →



In a low density nesting situation, a separate page should be used for each turtle encountered. Sheets for multiple nesting by the same turtle should be collated. For *arribadas* or high-density nesting situations, fewer data may be recorded for each turtle, and data for several turtles may be included on one page of lined paper.

C.4.5 Determination of Hatching Success.

Sea turtle population estimates depend, in part, on accurate assessment of number of eggs laid and number of healthy hatchlings that emerge.

C.4.5.1 The *Sea Turtle Egg and Hatchling Data Form* accompanying this Manual (Form 6) defines the most important information needed for this assessment.

Form 6. Sea Turtle Eggs and Hatchling Data.

SEA TURTLE EGG AND HATCHLING DATA FORM

Date Nest Laid _____ If Not Fresh, Estimate Age (Days) ____ Species _____

Date Nest Hatched _____ Days _____ Nest Excavated by _____

Location of Nest _____

Tag No. of Turtle If Applies) _____ Incubation Method _____

Hatchling  Data

Hatched eggs (H), From which hatchlings escaped from eggs _____

Turtles Dead in Nest but Escaped from Egg (DIN) _____

Turtles Found Alive in Pipped Eggs (LPE) _____

Turtles Found Dead in Pipped Eggs (DIN) _____

Unhatched Eggs (UH) _____

Infertile Eggs with no Obvious Embryos (INF) _____

Unhatched Eggs with Discernible Embryos (DE) _____

Live Embryos (LE) _____

Mutations Found Alive in Nest (MA) _____

Mutations Found Dead in Nest (MD) _____

Survival Percentage of Hatchling from Nest (SP) _____

Comments: _____

Weight of 20 Hatchlings Selected at Random from Nest (Living Turtles Only) (Grams).

1. ____	6. ____	11. ____	16. ____				
2. ____	7. ____	12. ____	17. ____		X Weight	____	
3. ____	8. ____	13. ____	18. ____		SD	____	
4. ____	9. ____	14. ____	19. ____				
5. ____	10. ____	15. ____	20. ____				

Disposition of Hatchlings (Released, Pen-reared, Other _____)

C.5 Types of Data to Collect on Market Surveys.

1. Name and location of market.

2. Date visited.

3. Number of vendors offering sea turtles or parts thereof.

4. Tabulation (in words) on numbers and species of live turtles each vendor offered.

5. Tabulation (in words) of turtle parts each vendor offered for sale. Products may include cut meat, tortoiseshell jewelry, souvenir shells, etc.

6. State whether market survey was complete (i.e., all vendors visited and their products examined) or was based on a sample. If a sample, estimate proportion of total market surveyed.

7. Prices asked for turtles and turtle products (state typical price, highest and lowest prices; also state whether price is fixed or determined by barter).

8. Sources of turtles and season when available, according to vendors or other sources (interested or highly informed vendors should be asked the questions on the draft turtle survey questionnaire of Section C.6).

Measurements and Weights of Turtles Shells Seen:

Species: Sex:

Carapace length (straight): (curved):

Carapace width (straight): (curved):

Abnormalities and injuries:

Notes on color and encrusting organisms:

Weight:

Date and location of capture:

C.6 **Suggestions for Conducting Interviews:**

The following notes and draft questionnaire are suggested for use by scientists and fisheries officials when interviewing fishermen or residents of coastal districts.

Field procedure in sea turtle censuses and surveys should be a combination of direct observation and interviews. Repeated visits to one locale are difficult during most short-term surveys, but carefully planned interviews with knowledgeable local residents can yield data of great value. Interviews should be carried out systematically and with patience. The present outline aims to standardize interviews and ensure coverage of the key topics. The questioner ought to be prepared to conduct the interviews according to a mental checklist

of the survey's objectives as originally conceived and as modified from time to time. The objectives are much the same in any interview but the techniques will have to be flexible. Some informants may be willing and able to fill out a written questionnaire. Some may not. Asking a humbly educated informant to fill out a form can alienate him. He is likely to be even more offended when his answers are recorded verbatim. Taped interviews are useful, but some informants react negatively to requests to record the interviews, and even worse if recording is attempted secretly.

There are ways to surmount these problems. Keep in mind the procedural outline described below, and memorize the checklist. Write as little as possible during the interview but as soon as it is over, make notes and fill out the questionnaire in private. If there are gaps in the required information, and if the informant was good, return for additional questioning.

1. **Data on the Informant.**

You should record the informant's name, address, approximate age and occupation. Try to judge his reliability; what opportunities he has had to get first-hand information; where he acquired his familiarity with turtles; and over what period of time. This assessment is one basis for grading each completed interview.

2. **Species of Sea Turtles that Occur in the Area.**

Find out which species of turtles the informant believes are found in the area. Establish this by easy cross-questioning; avoid prompting or leading him into more elaborate answers than his knowledge justifies. Use the colour plates of this Manual to aid in obtaining species identifications, but the informant should describe the species he is familiar with *before* being shown the illustrations.

After confirming the occurence of a species, ask for all its local (vernacular) names (be they English, Spanish, Dutch, French, Miskito, Papiamento, Carib, or any other language or dialect in local use). When confident that the informant can distinguish one kind of sea turtle from another, record the names used and proceed with the interview.

3. **Seasonality and Ecology of Foraging Adults.**

For each species, determine whether mature turtles occur in the region and how the informant knows they are mature. Ask if the turtles are present during the whole year or only during part of the year. Get information on both seasonal residents and seasonal migrants (see below). Be careful that the informant doesn't confuse the two; they are different. Try to determine the abundance of mature resident turtles of each species and in what habitats they live. Expect only a relative assessment, because there is no known way to count turtles in most foraging habitats. Nevertheless, for each species of resident adults, try to get a valid impression of population abundance and the extent of any local foraging habitat.

4. Developmental Colonies.

Once the above data on resident adult turtles of each species are obtained, solicit the same information on the developmental stages, from yearling (20-30 cm) to submature sizes. Closely question anyone who seems to have a reliable understanding of the habitat distribution and seasonality of the various size classes.

5. Nesting.

The most reliable quantitative population information that can be expected from this survey will come from nesting census data, especially in areas where tagging programmes have been in progress. When asking questions about nesting, use charts and maps to identify likely sites of concentrated nesting. Also, get density-per-kilometer estimates for separate nestings by each species represented. Wherever warranted, supplement interviews with beach inspection and, in special cases, with aerial survey counts.

6. Changes in Population Levels.

Another aim of the interviews is to determine if local opinion suggests whether the local population is stable or, if unstable, the way and degree that the population is changing. Although it is hard or impossible to determine the reliability of population stability estimates in most cases, estimates of fishing effort expended per turtle caught is one useful approach.

7. Migratory Routes.

Migration, an important feature of sea turtle biology, has strong bearing on management. As suggested earlier, informants may not clearly distinguish migratory passage from the periodic occupation of developmental or foraging environments. During interviews, solicit local information about regular routes of migration. Ask the informant whether he has ever seen many turtles together at sea. If so, ask where, when, how many, what their average size was, etc. Ask what he believed the turtles were doing. Try to keep the idea of migratory movement separate from seasonal occurence in a place or habitat.

8. Exploitation.

In addition to gathering information on the kinds, abundance, seasonality, and habitat distribution of sea turtles, collect data on exploitation. Are turtles and turtle eggs used locally, exported, or both? What techniques do turtle fishermen use? During which seasons or months do they operate?

9. Turtle Laws and Regulations.

To judge public awareness of restrictions and regulations, ask the informant what he can tell you about local turtle laws. Determine if he knows if it is legal to catch turtles; if there are closed seasons, quotas, or size limits; if it is legal to take eggs. This information will not only help to evaluate public awareness of, and attitudes toward, sea turtle regulation, but also will pave the way for the next line of inquiry.

10. Incidental Catch.

Tag returns clearly show that, as shrimping fleets have grown, the frequency of turtles caught accidentally in trawls has risen strongly. Obtain estimates or records, if they exist, of numbers of turtles captured this way. Try to determine which species and size groups are caught, whether they are eaten by the boat crews and their families or are sold, and whether there are regulations to control such incidental catches.

C.6.1 DRAFT QUESTIONNAIRE

1. Data on the Informant:

Name: Sex: Age:

Address:

Occupation:

2. Species of Sea Turtles in the Area:

a. How many kinds of sea turtles are known here? Describe them.

b. What local name is used for each of them?

CC = *Caretta caretta*	loggerhead
CA = *Chelonia agassizi*	black
CD = *Chelonia depressa*	flatback
CM = *Chelonia mydas*	green
DC = *Dermochelys coriacea*	leatherback
EI = *Eretmochelys imbricata*	hawksbill
LK = *Lepidochelys kempi*	Kemp's ridley
LO = *Lepidochelys olivacea*	olive ridley

c. How do the various species rank in abundance?

d. Beside the turtles shown in Colour Plates 1 - 32 (Annex I), do people ever speak of other kinds here? Is so, what are their names; and what do they look like?

3. Seasonality and Ecological Distribution of Foraging Adults:

a. Do fully grown turtles occur here? Which species?

b. Which species live in local waters year round?

c. During what seasons do other species occur?

CC = *Caretta caretta*	loggerhead
CA = *Chelonia agassizi*	black
CD = *Chelonia depressa*	flatback
CM = *Chelonia mydas*	green
DC = *Dermochelys coriacea*	leatherback
EI = *Eretmochelys imbricata*	hawksbill
LK = *Lepidochelys kempi*	Kemp's ridley
LO = *Lepidochelys olivacea*	olive ridley

d. If turtles are seasonal here, do you have any idea where they come from?

e. How do you know this?

f. Do turtles arrive and depart on a predictable schedule, or a variable schedule?

g. In what kinds of habitats does each turtle species occur: channels, reefs, turtle grass beds, *Gorgonia* beds, mangrove creeks, others?

h. How many of each kind of turtle do you catch in a year?

i. On a good day, how many (total) do you catch: by netting, harpooning, diving, or by other methods?

j. How many days per month or per year do you fish for turtles?

k. Are there sea grass beds around here? Do you see adult turtles feeding on these grass beds?

l. Are there reefs around here? Are turtles common around these reefs?

m. Are there places where turtles are especially numerous?

n. Do you ever see turtles offshore? How far out? Which species? What size? Are they in groups? What did they seem to be doing? Are they associated with driftwood, seaweed, or just in the open sea?

4. **Seasonality and Ecology of Developmental Stages:**

a. What sizes of each species do you find?

b. Which species of small turtles live here year round?

c. Do you find different types of small turtles in the same habitat? If not, what is the best type of place to find each kind?

d. Do the different sizes of the same species appear at different times of year?

5. **Nesting:**

a. Do sea turtles nest locally? If so, which species? What seasons? Which beaches? How many in an average year?

CC = *Caretta caretta*	loggerhead
CA = *Chelonia agassizi*	black
CD = *Chelonia depressa*	flatback
CM = *Chelonia mydas*	green
DC = *Dermochelys coriacea*	leatherback
EI = *Eretmochelys imbricata*	hawksbill
LK = *Lepidochelys kempi*	Kemp's ridley
LO = *Lepidochelys olivacea*	olive ridley

b. Are there any places where many turtles gather to nest together? If so, where? What species are involved? Does this happen occasionally or regularly? When?

6. **Changes in Population Levels.**

a. Are sea turtles generally rarer, more numerous, or about the same today in comparison to years past?

b. How would you rate their abundance today as compared with 10 years ago, or 25 years ago?

c. To what do you attribute these changes? To annual catch? To changes in effort that has to be spent catching a turtle? To changes in nesting density on local beaches? To information you have seen in print? If so, where?

7. **Migratory Routes:**

a. At certain times of the year, do you see turtles pass by that seem to be going to a particular locality?

b. If so, which species? What sizes? In groups, or singly? How big are the groups?

c. Describe the route they seem to be following.

d. Which way does the main current flow in this area? Does it affect the turtles' movements?

8. **Exploitation:**

a. Is turtle meat sold locally? Is there demand for the meat throughout the country or only among the coastal inhabitants?

b. What is the current price of turtle meat per pound or per kilo?

c. Is meat exported to other countries? To which countries? Where is it processed?

d. How important is turtle meat in the diet of local people?

e. Which kinds of turtles other than green turtles are eaten, or sold for food?

f. Are turtle eggs sent to market? If so, what is the order of preference, if any, for eggs of the different species? Does the sale of eggs extend throughout the country or just along the coast?

g. Is there a market for turtle skins? What kinds of turtles are used? Who buys them? What prices are paid?

h. Is there a market for tortoiseshell? Is the market local or foreign? How much does the shell sell for (either by weight or per turtle)?

i. Are small turtles preserved or stuffed for sale to tourists and local residents? Which kinds? How much do they sell for?

j. Are turtles caught with spear guns, or by swimming, netting, or on the beach? By local people or by visitors?

k. How many people here hunt turtles for their main source of income? Are turtles captured by other fishermen as well?

l. How much subsistence capture is done by people who use their catch only themselves or among their family and friends?

m. Have the recent restrictions on international trade in sea turtle products had any effect on turtle hunting here?

n. If all export of turtle products were to stop, what would be the effects on local employment and local economies?

9. **Turtle Laws, Poaching, and Smuggling:**

   a. Do you consider the laws that prohibit or restrict taking and selling turtles fair or unfair?

   b. Are the turtle laws generally respected, or do a lot of people poach?

   c. Does the government make a strong effort to enforce turtle laws? How many officers does the government employ to enforce turtle laws locally?

   d. Do the enforcement officers carry out their job, or are they half-hearted, or timid?

   e. Have you ever heard of anyone getting caught for violating the turtle laws? Have you ever heard of anyone being punished?

   f. What kind of penalty usually is imposed?

   g. How do poachers avoid the enforcement officers?

   h. How many people would you say regularly take eggs or turtles illegally?

   i. How important do you consider poaching's effect on the survival of local species?

10. **Incidental Catch:**

   a. Do trawlers work in local waters? Are they here all year or just in certain seasons?

   b. Do trawlers catch sea turtles? How do you know this?

   c. Has this incidental catching of turtles increased lately?

   d. Which kinds of turtles do trawlers take, what sizes, and with what relative frequency?

   e. Do the turtles usually drown in the net, or do most survive?

   f. Are turtles caught by trawlers eaten, sold, or released?

D. Management and Conservation

The World Conference on Sea Turtle Conservation, held in Washington, D.C., USA, in November, 1979, published a "Sea Turtle Conservation Strategy" of world-wide scope. This may be used as a reference document to establish priorities for national sea turtle conservation programmes.

International co-operation, exchange of personnel, and consultation between turtle researchers and conservationists play an extremely important role in effective sea turtle conservation and management. For example, when many developing countries first established sea turtle programmes, they arranged for national personnel to gain vital experience by participating in established turtle programmes in other countries. Such exchange programmes have many admirable results and invariably both veteran and novice researchers learn much that is new to them.

Recently, many national and international conferences on marine turtle biology and conservation have been held. Anyone contemplating a major commitment of time and energy to sea turtle work should try to attend such meetings. Regional meetings such as those of IOCARIBE can be especially valuable. New information that passes by word of mouth at such meetings may not actually be published for several years, if ever.

D.1 Beach and Nest Protection

The procedures recommended for nesting beach protection depend on the kind of predation and other conditions at any particular site. Most turtle conservationists agree that protecting nesting turtles is essential to maintain a viable population. Collection of eggs for human use must be carefully controlled, and in most cases, totally forbidden until turtle populations again reach acceptable levels.

Turtle eggs may be lost to:

a) Nest predation by man.

b) Nest predation by domestic animals.

c) Nest predation by wild animals.

d) Erosion of the beach and other abiotic factors.

e) Nest destruction by later-arriving turtles digging their own nests.

The investigator or turtle conservationist must monitor nesting and hatching to estimate the overall percentage of eggs that are lost for one or another of the above reasons. If losses are not great, manipulation or management of nests may not be necessary. If losses are great, protective measures should be instituted as soon as possible and continued as long as necessary.

D.1.1 Control of Predation by Man

The first conservation priority is to keep egg collectors and turtle poachers away, and to bring natural predators under control. Beach patrols are usually necessary for this. Several nations have found that a good course of action is to hire the most active poachers to work on these patrols, if it can be ensured that they will not draw their pay while continuing to poach for profit. Such an approach curbs exploitation while drawing on the poachers' experience and expertise to benefit the turtles.

Effective patrols can be organized with assistance from military organizations, conservation officials and interested amateurs. Where sea turtles are under the auspices of fishery departments, local legislation might need amendment to enable enforcement officials and other wildlife specialists to assist in turtle patrols. If properly trained and organized, local amateur groups and naturalist societies greatly assist beach patrol and turtle protection efforts. Turtle hunters may be armed, and some turtle beaches can be dangerous. So care must be taken in recruiting amateur aides.

D.1.2 Control of Domestic Predators

Domestic animals such as dogs and pigs destroy sea turtle nests and eggs on many beaches and must be controlled. When predator restraint or elimination is not possible, the nests should be moved to a suitable protected area.

D.1.3 Control of Wild Predators.

Under normal circumstances, wild predators such as racoons and coyotes should not be exterminated. They should be controlled, however, when they are extremely populous and are destroying a large number of turtle nests, or where the turtle nesting population is already endangered. No entirely satisfactory control mechanism for such predation has been found. Experiments to reduce raccoon predation on loggerhead nests in the United States have had variable results. Experiments in which eggs are moved from the original nest to a facsimile only a few yards away show some promise; both human and animal predators may be foiled by this strategy. But in many cases, a hatchery may be the only means of controlling predators.

D.1.4 Protection from Beach Erosion

Turtles may nest too close to the sea or in areas where high tides or storms are likely to erode the beach during incubation. The conservationist has several options discussed in Section D.1.6.

D.1.5 Protection from Later Nesting Turtles

There are a few places in the world where turtles nest in such density that numerous nests are destroyed when other turtles subsequently arrive and dig in the same spot on the beach. Such nesting sites are unique natural laboratories for studies of what may be one of the few natural limits on turtle populations. But these beaches also provide an opportunity to enhance hatchling survival by moving some of the early-season nests to protected locations.

D.1.6 Egg Handling and Relocation

Sea turtle eggs should be allowed to incubate in their natural beach setting whenever they are likely to survive. Practical conservation management, however, sometimes requires that the nests be relocated. Consider moving the nests when one or more of the following situations occurs:

a) Heavy poaching has occurred in the nesting area during previous nesting seasons.

b) The nest is too close to the sea. (For successful hatching, eggs should be laid well above the average high tide level).

c) The nest is very close to intense, artificial lighting.

d) Beach cleaning equipment is used near the nest.

e) Local populations of turtle egg predators such as crabs, pigs, lizards, etc., pose a threat.

f) Human use of the beach, including vehicle traffic, is intense.

g) Plant roots obstruct the upper part of the beach in a way that might block successful hatchling emergence. Hatchlings usually emerge from a beach hatchery at night, but depending on the species and the location, hatchlings may emerge any time from shortly after dusk to shortly before dawn.

Relocated eggs may have a lower than normal hatching success, but careful handling and transport of eggs partly counteract risks of relocation. In fact, some evidence suggests that eggs handled, moved and incubated correctly have better hatching success than eggs that remain in natural nests. More experimentation is required to confirm this observation.

Eggs may be collected for relocation either during the laying process or later from the closed nests. Eggs can be removed during laying and before the turtle covers the nest. Taking care not to disturb the nesting turtle, deftly scoop the eggs out of the bottom of the hole or catch them gently in a plastic bag as they drop from the vent. Or, eggs may be excavated and retrieved from marked nests.

When excavating a turtle nest in which the egg pit was not precisely marked during laying, the following cautions are recommended:

a) Use extreme care in attempting to locate the eggs. To avoid punctures, only experienced personnel should use a probe to find eggs. Digging by hand is preferable. In most cases, the egg pit is on the seaward side of the nest, about 1/2 metre deep. Leatherback and green sea turtles, however, bury their eggs much deeper. Unless there is considerable time to dig by hand, probing may be necessary. The probe should be a wood or metal rod about 3/4 cm in diameter and 1 to 1.5 metres in length. Whether probing or digging, be careful not to trample the nest area and compact the sand which will make locating the egg pit even harder. Once the probe starts "giving way" as it is pushed slowly through the sand, extract it immediately to avoid puncturing any eggs.

b) Once the eggs are located, excavate them by hand. A shovel is likely to break many eggs. Handle and transport eggs quickly, but with utmost care. Place them on top of a thin layer of beach sand in a rigid container such as a styrofoam, wooden or cardboard box, or a strong basket. Hatchlings have a better chance to survive when eggs are removed and reburied within about six hours after laying.

If eggs are more then about six hours old, few will survive relocation unless they are kept with the upper surface or pole upright (ie: without rotation). Maintain this orientation at all times when removing them from the nest, placing them in the container and transporting them. Put them in the new nest with the same axial orientation.

D.1.6.1 Beach Hatcheries.

A beach hatchery should be located in a well-drained, unshaded level area that is free from vegetation. Although many designs for in-ground hatcheries have been used, the following design criteria are widely accepted (see also Figure 20).

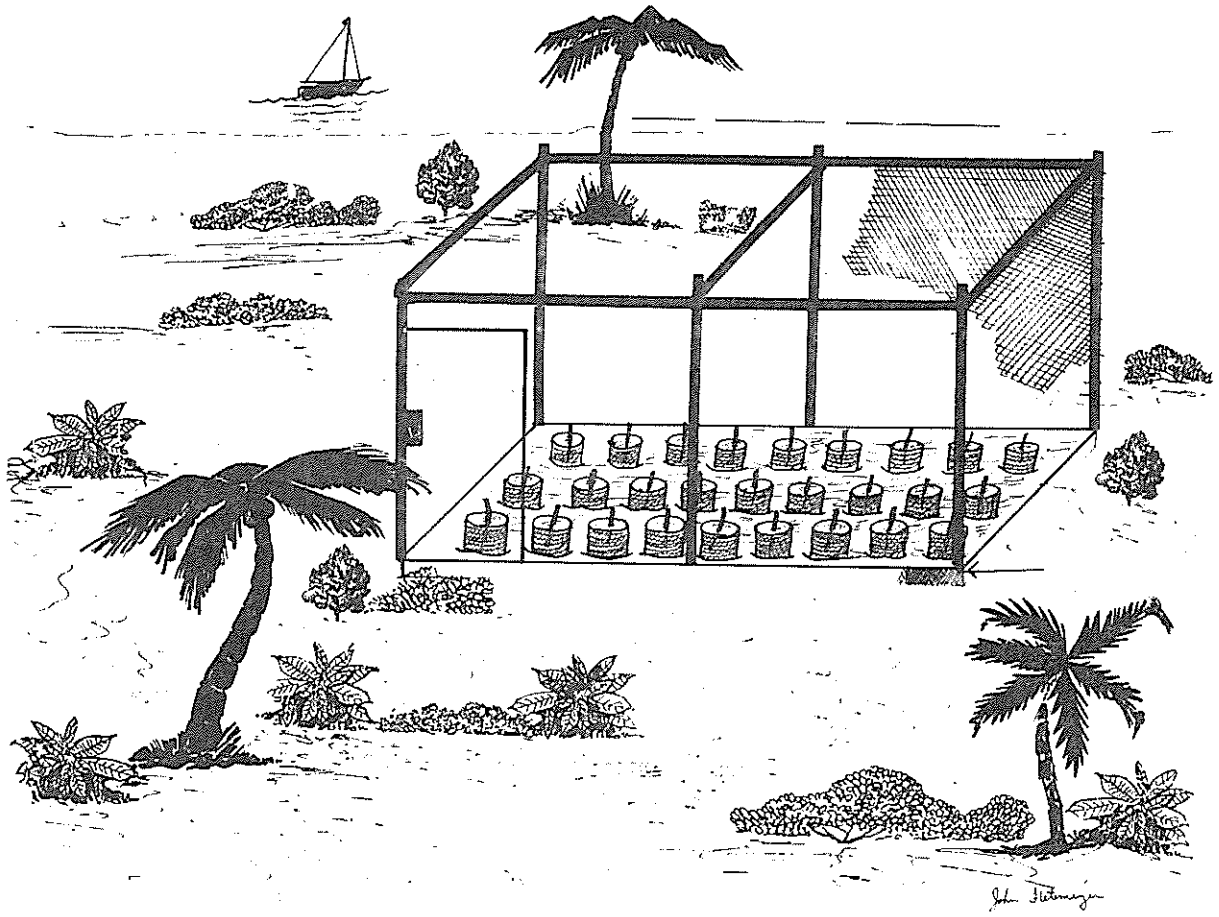


Figure 20. Suggested design for an in-ground hatchery (see D.1.6.1).

a) The hatchery should be enclosed completely (sides and top) with aluminized or vinyl-covered wire mesh screen to keep out egg and hatchling predators.

b) The sides of the enclosure should be sufficiently strong to keep out mammalian predators such as raccoons and pigs. The sides should extend about 1/2 metre into the sand to keep out crabs and other burrowers.

c) Nests within the hatchery should be planted above the level of ground water, but not in completely dry sand as some moisture is essential for hatching. During very dry weather the nests might need to be moistened with a sprinkling can containing fresh water.

d) Wasted space should be avoided to reduce construction costs. When a hatchery is to be used throughout the nesting season, nest space can be reused because incubation takes only about 50 days. The enclosure must be large enough to allow nests to be located about one metre apart to avoid trampling by personnel working the hatchery.

e) An artificial nest should resemble a natural nest in depth, diameter and shape. Each egg in the artificial nest should be in contact with other eggs. An enclosure of strong wire netting (having an approximate opening of 1 cm) should encircle each nest. The circle should be about 40 cm in diameter and 30 cm high, with the lower 5 to 10 cm buried in the sand. Emerging turtles will be trapped within the circle and should be counted before release. Most hatchlings emerge from the nest simultaneously, but stragglers may appear during the following few days. Always check all nests for any emerged hatchlings very early in the morning (no later than about 9 a.m.) and remove any hatchlings promptly or the sun and hot sand may kill them. Five days after the initial emergence, excavate the nest and count any infertile eggs or dead embryos. Ghost crabs or other burrowing predators may have ruptured other eggs so the number of whole infertile eggs plus the number of hatchlings will not always equal the total number of eggs in the clutch.

Wild or natural nests may be excavated in the same way after the young emerge, but exact calculation of the hatching success is seldom possible unless the eggs were counted as they were laid and the emerging hatchlings were also counted accurately.

To preserve a dead hatchling found in an excavated nest, inject 25 percent formalin into the body cavity through the soft umbilical area. Submerge it entirely in 10 percent formalin for storage. To retain it for taxonomic study or other purposes, transfer it to alcohol. Sometimes a very freshly preserved hatchling's sex may be determined by histological section, although few laboratories currently are equipped to do such studies.

D.1.6.2 Enclosed Hatchery Buildings.

Although this Manual recommends incubating turtle eggs in a beach hatchery with artificial nests that closely simulate the natural nests as described above, sometimes such incubation techniques are impractical. When necessary, eggs can be incubated in containers in an enclosed building. Some researchers question this practice, however.

An enclosed hatchery must have good ventilation to maintain ambient temperatures that approximate beach nest temperatures; some research, though inconclusive, has suggested that the high or low limits of a species temperature range may affect the sex ratio of the hatchlings. Styrofoam "cool-boxes" offer incubating eggs fairly good protection from temperature fluctuations in an enclosed hatchery. The containers should be approximately 30 x 25 x 20 cm (internal dimensions). Adequate but less acceptable alternatives are polyurethane garbage containers or plastic 20-litre (5-gallon) buckets.

When transferring a clutch of eggs to an incubation container, carefully observe the following procedure:

a) Drill or punch several small holes through the bottom of the container to facilitate drainage.

b) Line the bottom of the container with inorganic fine-mesh screen, such as nylon, to keep out sand and ants.

c) Spread about 3 cm of beach sand on top of the mesh screen.

d) Place the eggs on top of the sand layer. Duplicating the position in which they were laid in the natural nest is crucial. Each container or "cool-box" should hold a maximum of three layers, or about 80 eggs. If a natural nest contains more than about 150 eggs, divide the clutch equally and place the eggs in two separate containers.

e) Cover each layer of eggs with fine-mesh screening to keep sand from settling between them.

f) Finally, carefully pour at least 3 cm of sand over the top of the eggs and mesh. Check the sand's moisture content by pinching the surface of the sand with the thumb and forefinger. If a small peak of sand remains after the finger pressure is released, the moisture content is right. If the peak collapses, the sand is too dry. Moisten the sand with a sprinkling can containing fresh water.

D.1.7 Release of Hatchlings

Monitor nests daily for emergences from both in-ground and indoor hatcheries. During cool, overcast or rainy weather, many hatchlings might emerge by day. As a rule, transport them immediately after emergence to a suitable site on the beach and release them (unless there are plans for a head-start programme). Keeping them too long retards their neonatal activity level; they will either fail to move when placed on the beach, or will be too sluggish to avoid predators. On beaches where hatchlings released during the day are subject to excessive predation (from birds, fish, etc.), many hatchery managers release them after sunset.

Released turtles may become disoriented, not only during their move to the water but also at sea. Carefully select a release site that is relatively free from natural predators. Do not release turtles near artificial lighting, piers, oil rigs or lighted offshore structures.

Turtle biologists disagree about the best method for releasing hatchlings. Some maintain that natural conditions should be duplicated as closely as possible. They advocate liberating the newly hatched turtles high on the nesting beach so that if this phase plays a critical role in "imprinting", the turtle will return to the beach when it matures. Other researchers recommend taking the hatchlings by boat and releasing them beyond the surf line to avoid the high concentration of predators often found on the beach and in the surf. Both techniques should be used and in some cases combined; allow some turtles to run to the sea on their own, and others for release beyond the surf line. If a large hatchery is being operated, do not release all hatchlings in the same place, but distribute them randomly at points well away from the hatchery area to avoid attracting predators.

D.2 Incidental Catch.

D.2.1 Background

In some areas, incidental catch appears to be a major mortality factor for sea turtles. Turtles that become trapped in fishing nets during shrimp and fish seining may be injured or drowned. In addition to being an obvious problem for turtles, their incidental catch may interfere with commercial fishing operations and damage the gear.

D.2.2 Avoidance of Incidental Catch

This problem may be partly if not completly avoided and, consequently, the mortality reduced in three ways:

a) Areas frequented by large numbers of turtles can be identified and fishing activity in such areas be restricted. Restrictions may be necessary only during certain seasons if the turtles concentrate for feeding or nesting only.

b) Trawl nets and other fishing gear should be pulled up more frequently. A turtle rescued from a net in less than one hour of trawling normally has a good chance of survival.

c) Use of an excluder device on trawl nets reduces incidental catch significantly. The most effective device uses a spring-loaded trap door in the bottom of the trawl that opens to release large, heavy objects such as turtles and then closes again. Information on this can be obtained from the Southeast Fisheries Center, NMFS, 75 Virginia Beach Drive, Miami, Florida 33149, U.S.A. Request NOAA Technical Memorandum NMFS–SEFC–71 which contains detailed instructions on how to assemble, install and use an excluder device made from easily obtainable hardware.

D.2.3 Resuscitation of Apparently Drowned Sea Turtles.

The time it takes to drown a turtle held under the surface by a trawl or other net is variable. The metabolism, and thus the oxygen demand, of a submerged turtle depends upon several factors, principally ambient temperature and activity level. Turtles caught in very cold waters, particularly dormant individuals dredged from winter hibernation sites, probably have a low oxygen demand and can survive for some time in a trawl. On the other hand, a turtle caught in a trawl in the tropics or in temperate zones during the summer has a high temperature, a higher metabolism and thus a shorter survival time in a trawl net. In addition, efforts to outswim an approaching net and struggles to free itself once trapped further increase its oxygen demand and dangerously shorten survival time.

Sea turtles caught in set nets or trawl nets may appear dead when brought to the surface or on the the deck of a vessel. These animals do not move and their breathing and heartbeat cannot be observed without special instruments. Apparently lifeless turtles, however may not actually be dead but may be moribund (approaching death). Field observations have demonstrated that many are only comatose and often may be revived.

To resuscitate an apparently comatose or drowned turtle, place it belly-down on the deck. Prop up the rear end so that the head is considerably lower than the tail. In this position, gravity can draw the water out of the turtle's lungs. If the sun is hot, place the turtle in shade. An alternative resuscitation method is to place the turtle on its back and repeatedly push on the plastron with the foot to force the water from the lungs. Some turtles, however, die of anoxia without ever drawing water into the lungs while forcibly submerged for reasons that are still poorly understood. Never return a comatose turtle to the sea where it will definitely drown. Keep any apparently lifeless sea turtle out of the water for at least 24 hours and practice resuscitation, if possible, for 24 hours before presuming the turtle dead.

Sea turtles caught in nets and brought to the surface from very cold waters (less than 14^{o}C) may have been hibernating in bottom mud. They may be dormant or comatose. If they are simply thrown back to the cold water, some or all of them might die from hypothermal stress. Until the physiology of this apparent hibernation is more thoroughly researched and comprehended, protect any sea turtles brought up from cold waters by temporarily storing them in warmer water before returning them to the sea.

D.3 Legislation and Enforcement

Successful sea turtle conservation depends on action at local, national and international levels. The primary goal is to give adequate protection to turtles at all life stages, and to ensure that growth, and especially reproduction and recruitment, occur with minimal interference. In addition, human use, exploitation and marketing of turtles and turtle products must be rigorously controlled until turtle populations increase and sustainable yields can be calculated and controlled. A few countries, such as Costa Rica and the United States, have completely prohibited capturing or molesting sea turtles, and have banned imports or exports of sea turtles and their products for commercial purposes.

D.3.1 National Conservation Legislation

Detailed suggestions for sea turtle conservation legislation to suit the conditions in all countries cannot be given here, but in general protective legislation should:

a) Protect sea turtle nesting, foraging and migration habitats.

b) Give nesting females maximum protection during the breeding season on beaches and in inshore waters.

c) Give maximum protection to nests and eggs.

d) Regulate capture at sea. Capture at sea often causes less damage to populations than captures on beaches or the taking of eggs, but it still poses a threat and should be regulated. Complete bans on capture may be necessary where turtles are considered endangered.

e) Control all aspects of commercial marketing of turtles or their parts. Regulations should specifically forbid "holding", "offering for sale", or "causing to be offered for sale", any turtle or turtle product.

f) Impose penalities for violating protective legislation that are sufficiently large to prevent offenders from dismissing the fines as "the cost of doing business".

A nation or region starting a sea turtle conservation programme should begin by reviewing all pertinent existing legislation. In the archives of some countries are a tangle of old regulations—outdated, confused, generally unknown or ignored, but still technically in force. Such legislation may regulate fisheries, sale of foodstuffs, activites within coastal or marine areas and so on. If updated and rigorously enforced, these regulations may well give sea turtle populations their needed protection.

When some exploitation of turtles is politically or economically inevitable, there is an honest difference of opinion regarding conservation priorities – whether it is better to allow some eggs to be harvested, to stress protection of small turtles (i.e. with a minimum legal size), or emphaize protecting larger breeding turtles (i.e. with a maximum legal size). The final decision will reflect cultural and biological considerations. Whatever extent and type of exploitation is permitted, however, must be linked to positive conservation action. For example, if controlled capture of turtles at sea during the non-breeding season is permitted, active protection – by nesting beach patrols and, if necessary, by hatcheries – during their breeding season is vital.

D.3.2 International Conservation Legislation

Existing international legislation can support national sea turtle conservation programmes. Planners should familiarize themselves with various international conventions, and encourage their governments to ratify and enforce them. Because sea turtles migrate across national boundaries, international co-operation is essential.

Some of the relevant existing or potentially relevant conventions are:

a) **Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)**

This Convention was designed to control international trade in endangered species, and their products and parts. Species threatened with extinction, listed in CITES Appendix I, are subject to strict trade regulation. All sea turtles are now included in this list.

The last two turtle populations accorded this protective status were the Australian populations of *Chelonia mydas* and *Chelonia depressa* which were added to Appendix I at the CITES meeting in New Delhi in 1981.

Sixty-seven nations have signed CITES, though a few have taken legal exception to the specific listings of several sea turtle species regarding trade regulation.

b) **Convention on the Conservation of Migratory Species of Wild Animals (1979)**

This Convention provides direction and guidelines for conservation of migratory animals, including sea turtles, and provides a mechanism through which nations can unilaterally act to conserve endangered migratory species. *Lepidochelys kempi* and *Dermochelys coriacea* are listed in Appendix I of the Convention as endangered species requiring immediate protection, and all Cheloniidae and Dermochelydae are listed in Appendix II as species needing protection in certain areas.

c) **African Convention on the Conservation of Nature and Natural Resources (1968)**

This Convention theoretically offers a great deal of protection to sea turtles throughout the African continent; these species are listed as Class A (protected) species. In practice, several flaws exist: sea turtle eggs are excluded from coverage; nationals of Parties to the Convention are not covered when they operate outside their national territory; and the Convention's regional application does not cover all the sea turtle species involved. To date, 20 African nations have signed this Convention.

d) **Other International Conventions and Laws**

Several other conventions could be used to support national conservation efforts. Some have regional rather than global importance. Two that have great potential application, but which, unfortunately, do not presently cover any sea turtle species are:

i) The Convention on the Conservation of Nature in the South Pacific.

ii) The Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere.

In addition, Conventions and Treaties that ultimately may contribute to see turtle conservation, include:

i) The Convention on Wetlands of International Importance.

ii) The Convention Concerning the Preservation of the World Cultural and Natural Heritage.

iii) The Law of the Sea Treaty. Once it becomes international law, this treaty will affect Internal Waters, Territorial Seas, Exclusive Economic Zones, and the High Seas. Thus, it will embrace all sea turtle habitats except nesting beaches. Although not primarily a conservation treaty, it will help clarify and focus conservation responsibility for coastal resources such as sea turtles by allowing 200-mile exclusive economic zones for coastal nations.

D.3.3 Techniques for Setting Up Turtle Reserves.

The legal procedures for establishing turtle reserves and refuges clearly differ from country to country. Several government programmes proven effective in many countries are listed here; each nation can evaluate them in terms of its own local conditions. Laws or regulations protecting sea turtle habitats should be accompanied by legislation to protect the turtles themselves and their eggs. Enforcement patrols are necessary on intensively used nesting beaches. The patrols may be co-ordinated with biological research.

a) **National Parks.** These include designated areas where an ecosystem of national importance is maintained as undisturbed as possible. Both commercial and recreational exploitative activities are generally prohibited, though certain long-established activities in newly-designated park areas may be permitted for various reasons. Visitors to national parks are required to obey rules designed to protect the natural systems from damage. Many countries have established national parks which include and protect some of the world's most impressive landscapes and most important concentrations of wildlife.

Provincial and state governments may also establish parks and sanctuaries that can be as important and well-managed as national parks.

b) **Wildlife Refuges.** These areas may offer valuable protection for sea turtle breeding and nesting habitats. Recreational hunting and/or fishing is often permitted but this does not interfere with turtle protection.

c) **Private beach ownership.** Private conservation initiatives offer a nesting beach good protection when one or more concerned landowners purchase property adjacent to the beach, and as far seaward as ownership laws allow. This is particularly effective when national parks have a seaward extension sufficient to protect turtles in adjacent waters and on land. If the foreshore is privately owned, preventing access to a beach from the sea is difficult; turtles may be poached either on the beach or just after they re-enter the sea. Private initiatives, however, only last as long as landowners co-operate; it is generally better to base protective measures in law or regulation. Private conservation efforts, nonetheless, sometimes have a greater permanency than government programmes.

d) **Beach construction setback lines.** Forbidding construction too close to the sea's edge not only avoids property destruction but also protects dunes and turtle nesting habitats.

e) **Other measures.** In the United States, several additional programmes protect turtle's marine habitats. For instance, in an area designated as a Critical Habitat, federal activities or activities related to federal programmes are barred unless they are shown to be harmless to the affected species and their habitats. Two other useful federal programmes are the Marine and Estuarine Sanctuaries. In a Marine Sanctuary, exploitation of marine species is prohibited (sometimes with certain exceptions). In an Estuarine Sanctuary, adjacent land is purchased and both terrestrial and marine habitats are protected.

D.4 Care of Sea Turtles in Captivity.

This section describes captive culture of sea turtles for research and conservation purposes. Commercial culture is outside the scope of this Manual.

D.4.1 Culture Techniques and Requirements.

Hatchling sea turtles can be raised in captivity if water quality, temperature (minimum 17°C), sanitation, and diet are appropriately controlled. Experience has shown that some species are easier to raise than others: green turtles and loggerheads are probably the easiest, Kemp's ridleys are difficult, and leatherbacks are definitely the hardest to raise in captivity.

a) Space. Young sea turtles of some species are very aggresive in captivity. Kemp's ridleys in particular may violently and repeatedly bite each other if crowded. The resulting lesions may become infected and result in poor growth rates and an excessive number of deaths. Kemp's ridleys should be raised in individual containers. To diminish aggression to some degree in other species, use floating vegetation that allows turtles to hide from each other and weight the food so that it sinks. Turtles bite each other mainly during the excitement of surface feeding.

The space each turtle needs depends on the number of turtles kept together and other circumstances, so it is difficult to prescribe a fixed rule. A guideline is to provide a hatchling about one cubic foot (or 30 litres) of water and an adult 18 cubic feet (or 2/3 cubic metre). Careful observation usually reveals whether turtles are crowded; if they are unable to swim freely or develop necrotic lesions on their necks and flippers, the density probably should be decreased.

When raising turtles in an outdoor tank, shade part of the tank from the sun unless the tank is very deep. If predators pose a risk, particularly to small turtles, cover the tank with netting. If possible, roof the tank completely.

Land areas are not desirable in tanks for rearing young turtles, because the turtles may crawl out on them and become dehydrated.

Leatherbacks do not adapt well to captivity and they swim into the walls of any enclosure injuring themselves severely. Draping enclosure-~~walls~~ with a flexible material helps protect the turtles from injury. Sponge rubber "curtains" are not recommended because of their tendency to accumulate organic matter.

b) Sanitation. Hatchlings of all species are sensitive to water pollution, and will suffer if pathogens reach high levels. Housing the turtles in "crawls" or other marine cages that are constantly flushed by sea water reduces pollution. Turtles, however, may escape during storm or other high tides while young turtles housed in tanks on land are more secure. If possible, install a system to supply fresh sea water continuously. Flushing and completely refilling the tanks once or twice daily is an acceptable alternative. In inland installations where sea water must be conserved or other water used, a closed circulation system with adequate filtration and sterilization gives satisfactory results. Do not allow organic matter to accumulate in tanks. Pass-through systems should be drained and sterilized periodically, and tanks drained daily should be sterilized before refilling.

c) **Health.** A detailed discussion of health care and disease control in captive turtles is beyond the scope of this Manual. In general, isolate sick animals and keep them in scrupulously clean water. External lesions will heal faster if painted with Gentian Violet or the turtle is immersed briefly in a solution of potassium permanganate (1 to 3 grams in 200 liters of sea water). Weekly, biweekly, or daily immersions in a potassium permanganate solution greatly prevents disease in captive turtles. A dilute silver nitrate solution can also be used, but it darkens the tissue.

d) **Feeding.** Post-hatchling turtles appear to be opportunistic feeders, and three species, green, loggerhead, and leatherback, have been raised on diets of jellyfish. Most species in captivity can be fed proprietary food, pelleted food ("Trout Chow", etc.); filleted, skinned and boned non-oily fish, or the meat waste from crab or shrimp processing. Vegetable matter such as lettuce, mangrove, *Sessuvium* leaves, seaweeds, and turtle grasses can supplement the diet of some species, particularly green turtles. Turtles raised on pellets or artificial diets should be fed more natural food, if possible, for a few days or weeks before release.

Leatherbacks of all ages apparently require a highly specialized diet. As they are unable to digest fibrous food, they must be fed jellyfish or similar substances. One worker had some success feeding them chicken livers, but another found this diet unsatisfactory. Do not feed leatherbacks fish or plants, because they cannot digest such material.

It is emphasized that this section is not a complete or detailed Manual on rearing sea turtles in captivity. Anyone contemplating a major turtle-rearing operation should visit facilities where turtles are being raised and consult in detail with their curatorial staffs.

D.4.2 Turtle Aquaculture for Direct Conservation or Population Restoration.

A topic much discussed among turtle conservationists is the "head-start" procedure, whereby turtles are raised in captivity through the very vulnerable early months of life, and then released.

By circumventing natural predators of young turtles, head-start programmes are intended to increase survival to maturity. However, this is still considered an unproven technique, because no clear-cut case has been reported of a head-start turtle reaching maturity and reproducing. Lack of documentation, however, may only reflect the inadequacy of present methods of tagging or marking young turtles. Indeed, recent evidence suggests that green turtles and Kemp's ridleys released from a head-start programme can function normally and integrate themselves into wild populations of sub-adults. Yet doubt remains as to whether turtles that spend the first months of their lives in captivity will have conditions of their natal beaches adequately imprinted in their adult behaviour. If not, they might not migrate to appropriate locations nor come ashore to nest when mature.

In deciding whether a given turtle population is suitable for head-start procedures, consider the following:

1) Head-start programmes are expensive and demanding (although some of the high costs may soon be reduced). The expense is justified only when the population is severely depleted and lacks protection from commercial exploitation.

2) No more than about 5 percent of the eggs laid should be head-started. The rest should be allowed to hatch and the young to reach the sea as naturally as possible.

3) Take all usual precautions to ensure maximum hatch of eggs (See section D.4.1 on hatchery techniques). After releasing the young, permit them to crawl down the beach on which their mothers nested. Then gather them for release as they enter the sea. This may prove to be a meaningless excercise but until researchers understand how turtles locate their nesting beaches, conservationists should mimic nature as closely as possible.

   In addition to following the captive cultivation techniques recommended in section D.4.1, head-start programmes should make an effort to prevent turtles from becoming too accustomed to one type of food. The curator also should prevent the turtles from associating him with feeding time, because this may cause the turtles to form inappropriate later responses to humans.

The duration of a head-start programme depends in part on the facilities available. If a significant number of turtles are to be kept for more than a year, extremely spacious facilities and abundant regular food supplies are necessary. Most head-start turtles are released after six to fifteen months. Some programmes keep them for from only a few days to two weeks, just enough time for them to absorb the yolk sac and acquire the ability to dive easily when threatened by birds. Such brief captivity, however, is not recommended because, while it gives the young turtle advantage in avoiding predators, it presents the risk that the turtle will exhaust both its "infantile swimming frenzy" and its neonatal food reserves in captivity which it needs in order to reach its feeding habitat in good condition.

Before releasing head-start turtles, tag them with the smallest available Monel flipper tags. Record each turtle's size and weight carefully so that later comparison can be made between captured head-start specimens and other turtles.

There are two philosophies regarding where to release head-started turtles. The first maintains that they should be placed in water where turtles in the same size-range naturally occur. The other advocates releasing turtles on their nesting beach at a time when hatchlings are emerging naturally. The latter treats the head-start turtles as if they were hatchlings, except that they are large enough to escape avian and certain marine predators. No decisive information is available on the relative merits of the two appraches. Therefore, the best strategy is probably to divide the head-started turtles into two groups and apply the first method to one and the second method to the other.

E. Glossary of Terms.

ABDOMINAL SCUTES – the third rearmost pair of plastral scutes; the largest of the scutes of the plastron.

ALVEOLAR – pertaining to the functional, or biting, part of the jaw.

ANAL SCUTES – the rearmost pair of plastral scutes.

AXILLARY NOTCH – the notch in the front part of the shell into which the front leg fits and from which it protudes.

AXILLARY SCUTES – the small scutes present in the plastron opposite the armpit in most turtles.

BEAK – the horny covering of the jaws, in turtles consisting of a single plate over each jaw surface. Also known as "rhamphotheca" or "tomium".

BICUSPID – having two cusps.

BIFURCATE – having two branches.

BRIDGE – the part of the shell of a turtle that connects the carapace and the plastron.

CALLOSITY – a roughened area of skin, sometimes with superficial, sculptured bone exposed or just below the surface.

CARAPACE – the dorsal shell of a turtle.

CARUNCLE – the horny tubercle on the snout of a baby turtle and used to cut through the eggshell.

CAUDAL – pertaining to the tail.

CENTRAL SCUTE – one of the (usually five) large scutes extending down the midline of the carapace, also called ventral scutes.

CUSP – a sharp projection, typically from the edge of the jaw.

FALSE CRAWL – the track left by a sea turtle that has ascended a beach but returned to the sea without nesting.

GULAR SCUTE – the frontmost (paired, occasional single) scutes of the plastron, except in sea turtles where the paired gular scutes are separated by an Intergular Scute.

HALF-MOON – a semicircular or otherwise shaped track made by a turtle that emerged from the sea but turned around and returned almost immediately.

HEAD-STARTING – the practice of raising hatchling turtles in captivity for the first months of life in order to give them a better chance of survival when released.

IMBRICATE – overlapping, as the shingles of a roof or the scutes of the carapace of a hawksbill turtle.

IMPRINTING – the theoretical procedure by which a hatchling turtle receives a life-long impression of its natal beach that enables it to recognize appropriate cues and relocate the beach when it matures.

INCIDENTAL CATCH – the capture of a species (such as a sea turtle) while fishing for another species (such as shrimp).

INFRAMARGINAL SCUTES – scutes situated between the marginals of the carapace and the pectoral and abdominal scutes of the plastron in certain turtles.

INGUINAL NOTCH – the notch behind the bridge and in front of the hind limb of a turtle.

INGUINAL SCUTES – scutes that form the anterior border of the inguinal notch.

INTERGULAR SCUTE – a small scute at the extreme front of the plastron of certain turtles, including sea turtles, that separates or partially separates the gular scutes.

LATERAL SCUTE – one of the (usually four, sometimes five or more) large scutes running along each side of the carapace. Synonyms are costal scute and pleurals.

MARGINAL SCUTES – the small scutes around the edge of the carapace.

NECROSIS – rotting or death of tissues.

PECTORAL SCUTES – the pair of plastral scutes that cover the thest area-third pair from the front.

PERIPHERAL BONES – the bones around the edge of a turtle's carapace that lie beneath the marginal scutes.

PHALANGES – the elongate finger or toe bones in the flippers.

PLASTRON – the shell covering the underside of a turtle.

POSTCENTRAL SCUTES – posteriormost scutes on each side of the median line of the carapace, forming the posterior shell margin.

PRECENTRAL SCUTES – anteriormost and median scute on the carapace, included in the shell margin. Synonyms are cervical scute and nuchal.

PREFRONTAL – a bone in the turtle skull that extends from the nasal opening to the anterior part of the orbit; also a scale covering this area.

SERRATED – having a saw-toothed edge.

SYMPATRIC – occupying the same geographic area.

TEMPORAL – the sides of the skull behind the eyes.

TOMIUM – the biting surface of a turtle's jaws.

TUBERCLE – a small lump or knotlike projection.

F. **Sea Turtle References.**

This Manual is intended for use in locations without extensive scientific reference collections. Since the literature on sea turtles in vast and growing rapidly, the authors have not made literature citations in the text and have not appended the usual list of cited references. The following annotated references, primarily books with extensive bibliographic listings, are included, however, because of the broad scope of contained information and general applicability to this Manual.

American Zoologist, Vol. 20, No. 3, 1980

This symposium volume includes a series of invaluable papers on many aspects of sea turtle biology; the conference that led to these papers was unlike most sea turtle conferences in that it concentrated on scientific rather than conservation aspects.

BONNET. B., (Updated) 1980. Introduction bibliographique a la physiologie de la toi tue verte, *Chelonia mydas* (L.). *Collection Travaux et Documents,* No.4 (UER Sciences), 31 pp., Centre Universitaire de la Réunion, Université Francaise de l'Ocean Indien.

A valuable bibliography of the literature on the green turtle published between 1974-1979; includes papers on ecology, exploitation and protection, as well as physiology.

BUSTARD, H.R., 1972. *Australian sea turtles, their natural history and conservation.* Collins, 220 pp.

A detailed discussion of Australia's abundant sea turtle fauna, of interest to readers worldwide.

CARR, A.F., 1952. *Handbook of Turtles,* Comstock Associates, Cornell University Press, 542 pp.

Although now outdated, this was for years the standard work on all turtles of the United States, including sea turtles.

CARR, A.F., 1956. *The Windward Road.* Alfred A. Knopf. (Reprinted in 1979 by University of Florida Press; with new Foreword and new photos, 258 pp).

CARR, A.F., 1967. *So Excellent a Fishe.* Natural History Press, N.Y., 248 pp.

This is a sequel to *The Windward Road,* giving the answers to some of the questions raised in the earlier book, and discussing progress made in answering others.

HIRTH, H.P., 1971. Synopsis of biological data on the green turtle, *Chelonia mydas* (Linnaeus) 1758. *FAO Fisheries Synopsis.* No. 85.

An in-depth summary of available information on the green turtle as of 1971.

PRITCHARD, P.C.H., 1971. The leatherback or leathery turtle. *IUCN Monograph,* No. 1, 39 pp.

Although now outdated, this is a useful background document on available information on the leatherback turtle.

PRITCHARD, P. C. H. 1979. *Encyclopedia of Turtles.* T. F. H. Publications, Inc., 896 pp.

This is the current standard work on turtles of the world. It includes discussion of all species — land, fresh-water, and marine — but the sea turtle chapter is 76 pages long and includes colour photos of all the species.

PRITCHARD, P. C. H. and R. MARQUEZ-M., 1974. Kemp's ridley turtle, or the Atlantic ridley, *Lepidochelys kempi, IUCN Monograph No. 2.*

A useful summary of available information, as of 1974, on the most endangered species of sea turtle.

REBEL, T.P., 1974. *Sea Turtles.* University of Miami Press, 250 pp.

This is a book-length updating of Ingle and Walton Smith, 1974: Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico. Particularly valuable for the detailed bibliography.

RUDLOW, J.J., 1979. *Time of the Turtle.* Alfred A. Knopf, 267 pp. (Reprinted by Penguin Books, 1980.)

A highly personal and engaging account of the author's experiences with sea turtles and insights into their mysteries.

SCHULZ, J. P., 1975. Sea turtle nesting in Suriname, *Stichtung Natuurbehoud Suriname,* Verh. No. 3., 143 pp. (An updated Dutch language version is available as; *Zeeschildpadden die in Suriname leggen,* (1980).

STINASU (Paramaribo) Naturgids, Serie B, No. 5, 113 pp.

A model treatment of the sea turtles nesting in a single country, Suriname, where they have been intensively studied and conserved since 1964.

Washington Turtle Conference Proceedings. (In press).

This volume, when it appears, will be one of the most useful and detailed publications on sea turtles ever produced. Worldwide in scope, the included papers were presented in summary form at the World Conference on Sea Turtle Conservation, in November, 1979.

Seriously interested sea turtle students will wish to read the *Marine Turtle Newsletter.* The current editor is: Dr. Nicholas Mrosovsky, Department of Zoology, University of Toronto, Toronto M5S 1A1, Canada.

SEA TURTLE MANUAL OF RESEARCH AND CONSERVATION TECHNIQUES

ANNEX I

COLOUR PLATES

No. 1 - No. 32

PLATE 1. *Adult male loggerhead.* Note secondary male sex characteristics — tail extends well beyond a narrow, tapered carapace. Large head and reddish-brown carapace are characteristic of this species.

PLATE 2. *Adult male loggerhead.* Cloacal opening is located near tip of tail beyond posterior margin of carapace. Broad head is evident. Black sulfide-stained plastron is result of prolonged contact with silty bottom and is not typical of species.

PLATE 3. *Sub-adult loggerhead.* Two pairs of prefrontal scutes between eyes, five pairs of lateral scutes on carapace, and reddish-brown dorsal pigmentation are characteristics of this species.

PLATE 4. *Sub-adult loggerhead.* Three pairs of enlarged inframarginal scutes bridging the yellowish plastron are characteristic of this species. Emarginate scutes of carapace are common in immature individuals.

PLATE 5. *Juvenile loggerhead.* Dorsal scutes have dark brown lines radiating from light centers. Each center is elevated and forms a sharp keel of spine characteristic of this age class. Photograph is of a 10 month-old individual raised in captivity.

PLATE 6. *Hatchling loggerheads.* Variation in intensity of pigmentation between siblings is evident. Species characteristics regarding scute and scale number and arrangement are similar to adults.

PLATE 7. *Hatchling loggerhead.* Specimen is typically colored, but has an extra pair of posterior lateral scutes and an extra pair of enlarged inframarginal scutes. Posterior pair of lateral scutes are asymmetrical. Umbilical scar is present.

PLATE 8. *Juvenile Kemp's ridley and juvenile green.* The uniform black carapace is typical for Kemp's ridley up to about 28 cm carapace length (CL). The green exhibits a pattern of broadly radiating streaks on each dorsal scute, which is typical of immature individuals. The head of the green is proportionately smaller than heads of other species. The central keel of the carapace of immature Kemp's ridley is more pronounced than in adults.

1. Loggerhead

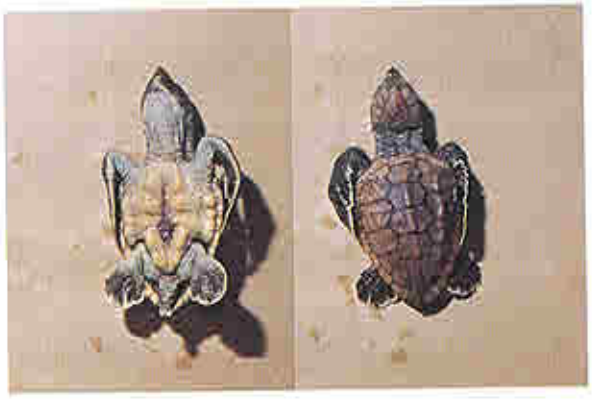
2. Loggerhead

3. Loggerhead

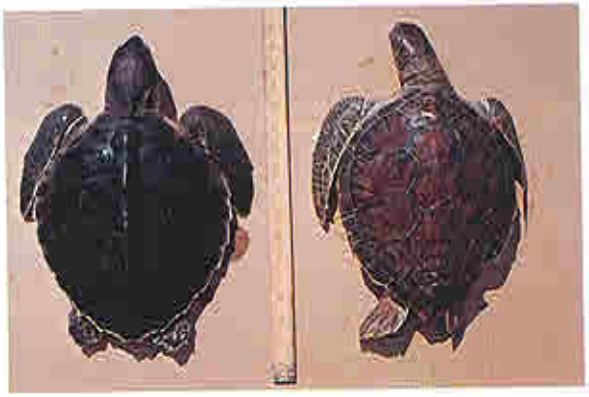
4. Loggerhead

5. Loggerhead

6. Loggerhead



7. Loggerhead



8. Kemp's Ridley (L.), Green (R.)

PLATE 9. *Juvenile Kemp's ridley and juvenile green.* Note keels on Kemp's ridley plastron and four pairs of enlarged inframarginal scutes, each with a pore centered on the posterior seam. The smooth, white plastron is typical of immature green turtles.

PLATE 10. *Sub-adult Kemp's ridley.* The olive-gray carapace of this older individual has replaced the black juvenile pattern except along the seams of the scutes. Distinct oval-shaped carapace, with five pairs of lateral scutes and two pairs of prefrontal scutes is characteristic of this species.

PLATE 11. *Sub-adult Kemp's ridley.* The yellowish plastron is typical of older individuals. Four pairs of enlarged inframarginal scutes bridging the plastron are present. The inframarginal pores are not clearly visible in this photograph.

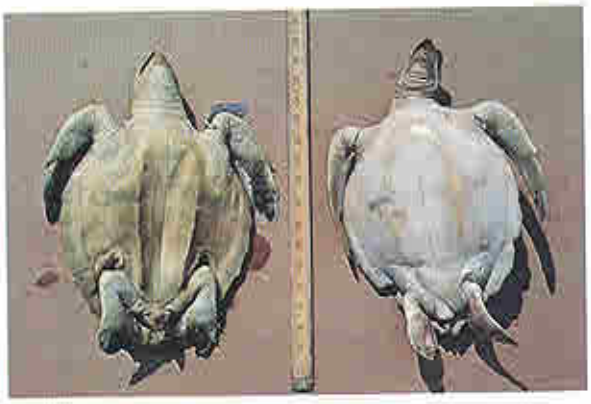
PLATE 12. *Sub-adult Kemp's ridley.* The small orbit located high on the skull above the deep upper jaw (supralabial scale) affects a parrot-like appearance — thus the Spanish vernacular name for this species, Tortuga Lora. The grey dorsal pigmentation of this immature individual is transitional between the black juvenile and light olive-green adult.

PLATE 13. *Juvenile Kemp's ridley.* The three elevated keels on the carapace, black dorsal pigmentation, and white plastron are typical of this age class. Photograph is of a nine-month old individual (10 cm CL) raised in captivity.

PLATE 14. *Hatchling Kemp's ridley.* Kemp's and olive ridley are the only species that have uniformally dark or black hatchlings. The five pairs of lateral scutes are typical for this species. Umbilical scar is present.

PLATE 15. *Adult olive ridley.* The dark olive carapace and the large and variable number (6-9) of lateral scutes are typical of this species. The oval-shaped carapace is characteristic of both ridley species.

PLATE 16. *Adult male hawksbill.* Note the brightly patterned carapace with thick, overlapping scutes. Scutes in juveniles and older mature individuals are not overlapping. Hawk-like narrow jaws and four pairs of lateral scutes are characteristic of this species. Elongate tail is exposed beyond posterior margin of carapace.

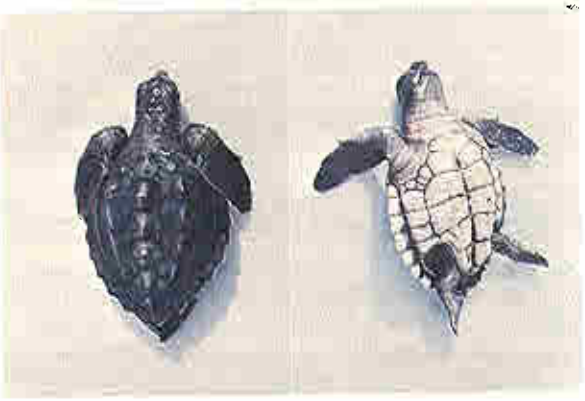


9. Kemp's Ridley (L.), Green (R.)

10. Kemp's Ridley

11. Kemp's Ridley

12. Kemp's Ridley



13. Kemp's Ridley

14. Kemp's Ridley

15. Olive Ridley

16. Hawksbill

PLATE 17. *Adult male hawksbill.* Note the elongated tail with the terminal cloacal opening (vent). The plastron and ventral area are yellow. The narrow jaws are characteristic of this species.

PLATE 18. *Adult hawksbills.* Color variation between individuals is great. Two pairs of prefrontal scales between the eyes are present in all of these individuals and are characteristic of this species.

PLATE 19. *Adult female hawksbill.* Bright or wet appearance of carapace temporarily lost while nesting. Note that the tail does not extend well beyond carapace.

PLATE 20. *Hatchling hawksbills.* Variation in coloration between individuals is evident. Superficially, these individuals resemble loggerhead hatchlings, but can be identified by their four, not five, pairs of lateral scutes.

PLATE 21. *Hatchling hawksbill.* Dorsal and ventral coloration and scute number and arrangement are typical. Note that the four pairs of lateral scutes on the carapace are all about equal in size.

PLATE 22. *Adult female green.* Relatively small head and four pairs of lateral scutes on carapace are characteristic of this species. Color of carapace has changed from immature pattern (Plate 8) to an olive-brown with a scattering of dark spots. Carapace of this species varies from light brown to almost dark. Dark individuals are more typical of the eastern Pacific region.

PLATE 23. *Adult female green.* Color and pattern temporarily obscured by drying of carapace while nesting. Small, rounded, and symmetrically shaped head is characteristic of this species. Female lacks the elongated tail.

PLATE 24. *Adult male green.* Light yellow ventral area is characteristic of the adults of this species. East Pacific individuals are darker. The sexually dimorphic and muscular tail of the male and distal position of cloacal opening are evident in photograph.

17. Hawksbill

18. Hawksbill

19. Hawksbill

20. Hawksbill

21. Hawksbill

22. Green

23. Green

24. Green

PLATE 25. *Adult green.* Unique scale pattern of the head for this species is clearly depicted by the single pair of prefrontal scutes between the eyes. Biting edge of the lower jaw is serrated (not visible in photograph) and is unique to this species.

PLATE 26. *Juvenile green.* This individual falls within the size range of the age class commonly referred to as "yearling". This is about the smallest size that occurs in coastal waters other than hatchlings migrating away from their natal beach.

PLATE 27. *Post-hatchling green.* The color and scute arrangement of this three-week old individual is typical of newly emerged hatchlings. Note the four pairs of lateral scutes and single pair of prefrontals, which are characteristic of this species.

PLATE 28. *Adult female leatherback.* Black dorsal area flecked with white spots and the absence of scutes are characteristic of this species. The seven dorsal longitudinal ridges run parallel to the body axis.

PLATE 29. *Adult female leatherback.* Some individuals are distinctly darker dorsally than others, but the ventral region is predominantly lighter in color. Four of the longitudinal ridges can be seen on the right side of this individual. The front limbs are very long and the skin is rubbery to the touch.

PLATE 30. *Adult female leatherback.* The unusual tooth-like cusps on the upper jaw are visible in this photograph. The pinkish cast to the ventral area is most conspicuous where the dark pigment is absent.

PLATE 31. *Juvenile leatherback.* Photograph is of a several-month-old individual raised in captivity. A mosaic of small scutes is present in hatchlings, but are shed after one or two months.

PLATE 32. *Hatchling leatherbacks.* This typical color pattern for hatchlings remains almost unchanged in the adult, except that the light markings on the dorsal ridges and flippers become obscure or disappear. The hatchlings are densely covered with a mosaic of small deciduous scales.

25. Green

26. Green

27. Green

28. Leatherback

29. Leatherback

30. Leatherback

31. Leatherback

32. Leatherback

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